University of Alberta

Assessing Canadian Consumers' Perceptions for Food Safety and Environment Safety

By

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Abstract

The objective of this thesis research study was to gain information on Canadian consumers' attitudes towards perceptions of food safety and agriculture-related environmental safety issues. The data used this thesis were collected through Canada-wide surveys conducted in January 2003 and October 2005 respectively.

Respondents' perceptions of food and agriculture related environmental safety as well as attitudinal and demographic information were obtained from the surveys. Analyses reported in this study suggest that gender, age, income and employment have appreciable impacts on risk attitudes and that trust in the food regulators and the marketing system are also significant influences on risk perceptions of various food and environmental safety issues. These findings give a better understanding of Canadian consumers' perceptions of risk and thus may contribute to policy makers' decision making.

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1 INTRODUCTION

1.1 Background

Over time there has been increasing public concern about issues of food safety and environmental sustainability. Modern food production and processing technologies can produce more food at reduced costs and with enhanced attributes, and the benefits of each new development seem to be greater than the drawbacks. However, some agricultural or food technologies may involve some risk to health and the environment. Because food is so important to life, consumers are concerned not only about cost and attributes but also any risks that may result from the application of food technologies (Hwang et al., 2005). These concerns have been highlighted by extensive media attention on the relationship between agricultural production techniques and human health (Lynch and Lin, 1994).

Food technologies include the use of pesticides, hormones, antibiotics and the use of genetic modification (GM) in food production. There have been debates concerning GM applications in agriculture. The benefits of this biotechnology in agriculture can involve increasing crop yields and reducing agricultural chemical inputs (pesticide or herbicide). Currently, the GM "family" is seen to include three generations. The "first generation" of genetically modified crops was modified for insect resistance and herbicide tolerance. Genetically engineered crops with traits for pest management have risen dramatically since their commercial introduction in the mid-1990s (Fernandez-Cornejo and McBride, 2000). These researchers checked farm-level impacts of such crops on pesticide use, yields, and net returns in the United States and concluded that herbicide-tolerant cotton resulted in significant increases in yields and net returns, but not significant changes to herbicide use, while adoption of herbicide-tolerant soybeans led to small increases in yields and decreases in herbicide use. Adoption of BT (*Bacillus thuringiensis*) cotton in the Southeast United States significantly increased yields and net returns and significantly reduced insecticide use (Fernandez-Cornejo and McBride, 2000). The "second generation" of genetically engineered plants refers to plants modified for product quality characteristics; proposed examples include a potential variety of

"functional foods", the proposed "third generation" of genetically engineered crops is suggested to be associated with plant-made pharmaceuticals (Stewart and Mclean, 2004).

Are new food technologies and food safety a source of consumer concern? A 2001 Canada-wide survey by Ipsos Canada (Ipsos Reid, 2001) reported that 35% of Canadian respondents were very concerned about the food they ate, while 39% were somewhat concerned and 10% were not at all concerned (Ispos Reid, 2001). Part of this concern may be based on inputs used in food production and processing, such as pesticides, hormones, antibiotics, and food additives. It seems that many consumers may be concerned about risks related to these practices, while food producers consider that the benefits of using these far exceed the risk. In fact, it is impossible to produce foods without the use of some chemicals (Baker, 2003).

Food safety concerns may also have increased because of the discovery of Bovine Spongiform Encephalopathy (BSE) in Europe and more recently, on a small scale in Canada. BSE has been a reportable disease in Canada since 1990. In 1993, BSE was found in a beef cow that had been imported from Britain in 1987 (CFIA, 2007). The animal was destroyed according to the Canadian Food Inspection Agency (CFIA) report (CFIA 2007). The first domestic case of BSE was reported on May 20, 2003. No meat from this animal went to market. Tests for BSE were negative for each of the other 2,000 animals slaughtered during the investigation of this case (CFIA). The second and third cases were confirmed on January 2 and 11, 2005, respectively. The fourth case was reported on January 22, 2006 (CFIA, 2007). By July 2007 Canada's BSE surveillance program had detected eleven domestic cases of BSE in Canada since 2003. The timeline of the eleven cases are as indicated in Table 1.

Table 1-1 Time Line for BSE Cases in Canada (May 2003 to July 2007)

BSE cases	Date
Case 1	2003-5-20
Case 2	2005-01-02
Case 3	2005-01-11
Case 4	2006-01-22
Case 5	2006-04-16
Case 6	2006-07-03
Case 7	2006-07-13
Case 8	2006-08-23
Case 9	2007-02-07
Case 10	2007-08-23
Case 11	2007-05-02

Data Source: Canadian Food Inspection Agency (CFIA), 2007
http://www.inspection.gc.ca/english/anima/heasan/disemala/bseesb/bseesbindexe.shtml

It is generally recognized that people's perceptions of risk and their trust in regulators or the food industry to reduce risks in the food supply may be important determinants of consumer reactions. Risk information from a trusted source can affect the perception of a particular risk. Risk information from a distrusted source may be considered as unreliable (Frewer et al. 2003). Understanding risk and perceptions of reliability of various sources of information could lead to more effective food policies aimed at maintaining consumer confidence in food safety. Consequently, knowledge of consumer reactions may play an important role in the effectiveness of any attempt to communicate risks (Rosati and Saba 2004).

Attitudes to food safety risks may change over time. Many new technologies have initially been opposed and eventually accepted. The opposite may also occur. For example, despite the hypotheses of a "knowledge deficit model" perceptions of risks associated with agricultural biotechnology seem to be increasing as more people hear about or learn about biotechnology. Thus, the level of concern about agricultural biotechnology seems to be increasing as public awareness of this new technology increases (Veeman, 2001). Increased awareness may have occurred as a result of increased media attention to biotechnology through newspapers and television. Even so,

consumers' views on biotechnology evidently show considerable variation (Hu et al., 2004).

Some studies have analyzed individual's perceptions of food-related health risks. For example, Dosman et al. (2001) examined Alberta respondents' perceptions of the level of risk associated with three food safety health-risk issues—pesticides in food, food bacteria, and food additives—and how these perceptions were influenced by the respondent's socioeconomic characteristics. They found that the majority of the respondents considered these food safety health-risk issues to be of moderate to high risk. Socioeconomic variables such as household income, number of children in the household, respondent's gender, age, and voting preferences were strong predictors of an individual's risk perceptions. Hwang et al. (2005) examined United States consumers' concerns with respect to eight food production and processing technologies. These authors analyzed ratings of concern toward eight food production and processing technologies. They found concern to be highest for pesticides and artificial growth hormones, followed by concerns about antibiotics, genetic modification, and food irradiation.

1.2 Objective of the Study

The objective of this study was to gain information on Canadian consumers' attitudes towards and perceptions of food and agricultural environmental safety. More agricultural technologies have been applied over the past several years and an increasing number of resources have been dedicated to informing the public about health and food safety issues. Previous studies have examined food-safety issues and their relationship to consumer perceptions (e.g. Dosman et al, 2001; Hwang et al, 2005). However, information on Canadian consumers' concerns regarding food and environmental safety is limited.

The specific objectives of the study were the following:

1) To provide an improved understanding of consumers' attitudes to identified issues of food and environmental safety. The specified food safety issues include: bacteria contamination of food, pesticide residuals in food, use of hormones in food production, use of antibiotics in food production, BSE (mad cow disease), use of food additives, use

of genetic modification/engineering in food production, and fat and cholesterol content. The specified environmental issues included: water pollution by agricultural chemical run-offs from agriculture, soil erosion through agricultural activity, genetic modification/engineering, resistance to herbicides and pesticides, adverse effects of agriculture on biodiversity, and agricultural waste disposal.

2) To analyze the impact of demographic and economic factors on consumers' risk perceptions. The demographic information may include gender, age, and income, number of children, education level, and place of residence. Attitudinal information will include a measure of consumers' trust in different institutions in the food system (for example, trust in the food industry or research institutions).

3) To determine whether there have been shifts over time in attitudes towards food safety and associated risks associated with agriculture.

The data used this thesis were collected through Canada-wide surveys that were conducted in January 2003 and October 2005 respectively. Since, as mentioned above, attitudes may have changed, for example, from the three cases of BSE that were found during this period, the study would also assess whether shifts in attitudes towards BSE and other food safety issues have occurred.

1.3 Thesis Organization

The thesis is organized as following: Chapter Two gives a review of relevant literature. In this review, previous studies on food safety issues are described. An overview of theory that relates to food safety perceptions is presented in Chapter Three. The source and nature of the data used in this study are described in Chapter Four. An initial comparison of the safety concerns expressed in the survey data collected in 2003 and 2005 is also made in Chapter Four. The economic model development is described in Chapter Five and estimation results from the regression analyses are in Chapter Six. Three types of models, SUR (seemingly unrelated regression), Oprobit (ordered probit) and Mprobit (multivariate probit) were initially used to analyze the effect of demographic characteristics and behavior variables on consumers' safety perceptions in the data set obtained in 2003. Based on these results, the data for 2005 are analyzed using ordered probit models to assess the nature of any changes in risk assessments between the two

time periods was outlined and estimated. Chapter Seven presents discussions of conclusions, policy implications and some recommendations for further research.

2 LITERATURE REVIEW

2.1 Factors Affecting Consumer Risk Perceptions

A number of studies have been conducted on consumer attitudes and perceptions of various food safety and environmental issues. Some recent papers have focused on biotechnology and pesticide use. Some researchers have conducted surveys on a single safety issue (e.g. Govindasamy and Italia, 1998 on pesticide use; Grobe et al., 1999 on hormones). Others have studied reactions to genetic modification of food ingredients, for example, Caswell, (2000); Finke and Kim, (2003); Veeman et al. (2003). Some studies have focused on perceptions of several issues. These include Nayga, (1996), who considered irradiation, antibiotics, hormones, and pesticide; Dosman et al. (2001) on pesticides, hormones, additives; Hwang et al. (2005) studied antibiotics, pesticides, hormones, genetic modification and irradiation.

Studies undertaken in the United States by the Economic Research Service (ERS) of the United States Department of Agriculture (USDA) concluded that most consumers were "completely confident" or "mostly confident" in the safety of their food. However, according to ERS (ERS, 2001) "The percent of consumers 'completely confident' or 'mostly confident' in the safety of the food supply increased from a low of 72 percent in 1992-93 to a high of 83 percent in 1996, with levels declining to 74 percent in 2000. Lower confidence may mean that consumers are more receptive to improving their food-handling behavior." (ERS, 2001)

Nayga (1996) studied socio-demographic influences on the concern of consumers in U.S. for food safety. He concluded that main meal planners who were female, less educated, with lower income, or those living in metro areas were more likely to consider food treated with irradiation, antibiotics, hormones or pesticide to be risky. Dosman et al. (2001) found that Canadian consumers' household income, number of children, gender, age and voting preferences were strong predictors of an individual's risk perception, and gender was significant for all models across two years in the study (1994 and 1995). Baker (2003) examined factors affecting American consumer responses to food safety

risk. He found that primary meal planners, women, and members of households with young children were the most likely to avoid risks in food supply.

Analysts relate three approaches to study and manage risk decisions of consumers: risk assessment, risk management and risk communication (Lobb, 2005). Risk management includes the measurement of consumers' risk perceptions, which is the focus of this study. Previous literature indicates that in general consumers' attitudes towards food safety and environmental safety tend to differ according to demographic and socio-economic factors such as gender, age, income, education level, and family size (number and age of children and or other people living at home). These influences are discussed below.

2.1.1 Socio-economic Factors and Consumer Risk Perceptions

Previous studies suggest that gender is an important determinant of risk perception across a variety of food and environmental concerns (Flynn et al., 1994). Flynn found that differences in risk perceptions primarily existed between white males and white females and perceptions of white females were much more similar to those of non-white males and females. He pointed out that "perhaps women and nonwhite men see the world as more dangerous because in many ways they are more vulnerable, they benefit less from many of its technologies and institutions, and they have less power of control" (Flynn et al., 1994, p.1107). Finke and Kim (2003) found that concern about potential health risks from genetically modified (GM) foods differed by gender; females were more concerned about health risks from GMs than males. This was also found by Hu et al. (2004). Dosman et al., (2001) found that women were more inclined than men to consider food additives, food bacteria, and pesticides as health risks.

Previous research has also found age to be associated with consumers' perceptions. Roe et al. (2004) reported that U.S. respondents who were less than 30 years of age had higher relative concern about genetic modification while respondents of age greater than 65 years of age had lower relative concerns regarding GM technologies. This group (>65) placed more concern on antibiotics and less concern on genetic modification (Roe et al., 2004). A study by Dosman et al. (2001) showed that the age of respondents

was an important influence in some of the models tested. In particular, the older the respondents, the more they perceived pesticides in their food to be a high health risk.

Respondent's household income and education level have also been found to be related to risk perceptions. Some researchers have found that households with higher levels of income and education exhibited lower levels of risk aversion. For example, Govindasamy and Italia (1998) reported that individuals with an annual household income less than US$40,000 were more likely to be concerned with pesticides than those with higher income. Similarly, those who attained only high school education were 10% more likely to believe that pesticides in food were riskier than individuals who had higher levels of education. Roe et al. (2004) reported similar findings: U.S. respondents with a lower income tended to give higher concern ratings. The explanation given by Roe et al. (2004) is that lower levels of formal education may be related to a lower ability to comprehend emerging scientific findings concerning the safety of food technologies. However, some researchers have found that household income and education level of respondents to be insignificant variables in predicting food risk concerns. Dosman et al. (2001) found that household income and education level of Canadian respondents were significant in explaining risk perceptions in their study using data from 1994, but were not significant in the analysis of data from 1995.

The number of children and the age of children in a household are believed to have an effect on respondents' perceptions of risk related to food and environmental issues. Dosman et al. (2001) reported that the more children there were in a household, the more likely the respondent was to perceive specified issues as health risks. However, the age of children and number of children in households in seem to have different influences on risk perceptions. Roe et al. (2004) found that respondents with older children had lower levels of concern about new food technologies. A similar finding was reported by Hu et al. (2004) for households with children. These households may be overwhelmed with other household issues (e.g., time availability, food cost, and convenience) such that the underlying technology used in food production and processing is a secondary concern.

2.1.2 Other Factors Related to Consumer Perceptions of Risk

The relation of trust and risk perceptions was studied (Slovic, 2000, Frewer et al., 1996). A new technology can be acceptable if society reaches a balance between the risks and the benefits associated with the technology (Slovic, 2000). However, the judgment of risk-benefit trade-offs is very difficult (Slovic, 2000). A few psychology-based studies have focused on the determinants of perceived risk. Information may affect perceived risk (Slovic, 2000). Increased scientific research on the effects of herbicides, fertilizers, pesticides, pollution and radiation has been the result of growing concern over environmental risks (Slovic, 2000). From a survey in Reading, U.K., Frewer et al. (1996) reported that individuals and organizations were trusted as sources of risk information and industry and the government lacked public trust.

The issue of trust in the food industry and regulators has become a focus of academic research and policy debates. "There is a widely held assumption that if people trusted scientists and regulators more then there would be fewer reasons for the public to challenge technological developments such as GM foods" (Gaskell et al., 2004 p.197). Through a survey directed to residents in Berkshire, U.K., Hunt and Frewer (2001) found that the views of possible health and environmental effects associated with GM food were different from non-GM food. Their findings implied that GM food was perceived to be risky. Rosati and Saba (2004) pointed out that the trustworthiness or reliability of risk information was hypothesized to be dependent on three determinants: perception of knowledge, perception of honesty and perception of concern. In analyzing views of food-related hazards in the U.S., they found that respondents chose consumer associations, research institutes and non-government organizations (NGO) focused on the environment as trustworthy information sources. These information sources were also perceived as the most knowledgeable about risks associated with food-related hazards, the most concerned about protecting the health and safety of citizens and the most honest in terms of completeness of information. In contrast, reporters and Government were perceived as less honest. Veeman et al. (2005) reported similar findings for Canadian respondents: industry and government were not rated as highly trusted sources of information, while research institutes and consumer associations were seen as more trustworthy. Grobe et al. (1999) assessed lack of trust in the Food and Drug Administration (FDA) as a food-

related information source and found this feature had a significant impact on respondents' risk perceptions. Those lacking trust in the FDA were more likely to be "very concerned" about the health effect of recombinant bovine growth hormone (rbGH).

Despite previous studies, there is a need for more work. First, what are Canadian consumers' current perceptions of food and environment related risks? Food industries and government may benefit from knowledge of consumers' attitudes to food and consumers' views of environmental concerns related to agriculture. More information on attitudes towards food safety is needed. For example, did consumers have different attitudes to BSE before and after the incidents of BSE in Canada? Secondly, it is an objective to identify some of the underlying factors that may affect respondents' risk perceptions. Thus in analysis of individual's ratings of food and environmental- related risks we incorporate and assess the influence on risk perceptions of socio-economic variables and demographic variables such as age, gender, education level, household income, number of young children, employment status, and proxies for trust.

3 THEORETICAL FRAMEWORK

3.1 Introduction

This chapter provides a brief outline of selected theoretical concepts that may be relevant to broadly defined issues of individual's reaction to food safety. Theories that attempt to explain the factors underlying risk perceptions include quantitative risks, the influence of qualitative characteristics of risk, and the role of trust as an influence on risk perceptions. These concepts are briefly noted here as are selected concepts relating to the economics of food safety.

3.2 Risk Perception Formation

Risk perception has been of interest to researchers and policymakers for many years. The concept of "risk" has been introduced to the field of economics and successfully applied in studies of consumer behavior (Dowling and Staelin, 1994). As Dowling and Staelin (1994) described:

"The concept of perceived risk most often used by consumer researchers defines risk in terms of the consumer's perceptions of the uncertainty and adverse consequences of buying a product (or service). In this way consumer researchers implicitly assume that both the probability and the outcome of each purchase event are uncertain." (Dowling and Staelin, 1994, p.119).

Wohl (1998) examined literature about the formation of risk perceptions. Individuals were postulated to use a Bayesian updating process to form their risk perceptions. That is, it is assumed that decision makers have some former perception about the risk and update their original perceptions when they receive new information. Following Wohl (1998), this process can be expressed as:

$$P_u = \alpha P_o + \beta P_r \qquad (3.1)$$

where:

P_u is the "updated", subjective estimate of the probability of an adverse outcome;

α, β are parameters;

P_0 is the probability of an adverse outcome held by the decision maker prior to the availability of additional information; and

P_r are reported probabilities.

Wohl (1998) points out that the values of α, β may reflect how much an individual trusts old and new information respectively and that these values can also reflect qualitative dimensions of risk perceptions. "The magnitude of β, then, has much to do with the level of trust an individual has in science that produces risk estimates and the trust he/she has in the relevant institutions to be truthful about what is understood about the risks" (Wohl 1998, p. 39). For example, if the individual completely trusts the source of information and has no previous notion of the risk perception, then s/he will update perceptions as did the information source. On the other hand, if the individual does not trust the source of information, then β will be zero and the "updated" perception will be the same as the previous one (Wohl 1989).

3.3 Information, Trust and Risk Perception

The relationship between risk perceptions and trust has been studied in the context of analysis of the impact of media and information on risk perceptions (Liu et al.,1998; Frewer et al., 1996). Trust is viewed as one of the most important components of risk perceptions (Frewer 2000). Consumers' risk perceptions have been suggested to be influenced by information from various sources (Liu et al., 1998). Specifically, information from government, industry, independent research institutes, consumer groups and journalists can be accessed directly and may also be transmitted through various media. Media stories can convey either positive or negative attitudes toward certain food safety issues. Negative news is believed by Starr (1984) to lead to reductions in consumption. Public trust may rely more on faith in the ability of the government to deal with the risk rather than remove it completely (Starr 1984). A negative effect may occur if information intended to promote consumption is from a distrusted information source (Frewer et al., 2003).

Further research is needed to understand the interaction of risk perception and trust. In this study, trustworthiness of different information sources is included as a hypothesized influence that has a direct impact on risk perceptions.

3.4 Introducing Qualitative Risk Concepts

While objective risk is based on scientific assessment of the probabilities of outcomes occurring from specified risk events (such as the probability of illness from a specific food contaminant), it has been observed by social scientists that such assessments are not identical to individuals' perception of risk, which are commonly referred to as "qualitative risks". Individual's risk perception can be influenced by psychological and sociological factors.

Slovic (1987) suggests several risk characteristics to explain decision makers' risk perception. In contrast to "voluntary" and "controllable" hazards, hazards with unknown adverse effects are seen as more risky, especially where these may be hard to imagine consequences. The characteristics of qualitative risk also include "dread." Voluntariness of risk is another qualitative risk dimension (risks undertaken by voluntary action are more acceptable than those that are non-voluntary). Acceptability is also associated with control over the risk, as well as the magnitude of risk, and knowledge about the risk (Slovic 1987). Slovic (1987) further analyzed three factors tending to influence public risk perceptions of the public. The three factors are "dread risk" (for example, nuclear power is dreaded more than vaccinations), "unknown risk" and "number of people exposed to the risk." Several other authors have reached conclusions of "dread risk", "unknown risk" and "number of people exposed to the risk" that are similar to those of Slovic relative to attributes regarding risk perceptions and attitudes (Sparks and Shepherd, 1996; Raats and Shepherd, 1996).

Slovic (1987) defines "dread" as "its high end by perceived lack of control, dread, catastrophic potential, fatal consequences and the inequitable distribution of risks and benefits" (Slovic 1987, p.283). Based on Slovic's definition, Sparks and Shepherd (1996) relate "dread" to "severity" (which includes "concern," "seriousness for future generations," "threatening widespread disastrous consequences," "dread," and "becoming more serious." (Sparks and Shepherd, 1996).

These studies of qualitative risks suggest that risk perception is formed more by the severity of the consequences of risk than the probability of occurrence. Slovic's theory is supported by data cited by Sparks and Shepherd (1996) who conclude that because of their severity bacterial contamination such as Samonella and Listeria were

rated as being more "dreadful" than general bacterial contamination (Sparks and Shepherd 1996). Raats and Shepherd (1996) reported pesticides to be highly rated on the dread factor while food coloring and caffeine rated relatively low on this factor.

Slovic (1987) uses the factor "unknown" to capture variables relating to the risk being unobservable or unknown, as with a new risk or where the risk is unknown to scientists. Raats and Shepherd (1996) relate "familiarity" with the "unknown" variable. They find preservatives and food coloring scored low while caffeine scored relatively high on "familiarity." Sparks and Shepherd (1996) further relate the factor of the risk being "unknown" with concepts of "risks not known to those exposed", "risks not known to science," and "less accurate risk assessment." Overall, people tend to be less willing to accept risk where the benefits associated with the risk are unproven or uncertain (Frewer et al., 1998).

The third qualitative characteristic specified by Slovic (1987) is the "number of people exposed to the risk." Sparks and Shepherd (1996) also studied this variable. Generally, members of the public are less willing to accept risks that affect larger numbers of people. That is, the greater the scope, the higher the perceived risk. These factors, arising from a psychological view, rather than solely quantitative measures of risk, influence public risk perceptions.

3.5 Review of Two Main Theories of Risk Perceptions

Psychologists who studied decision-making under risk proposed the psychometrics paradigm (Starr 1984; Slovic 2000). Starr's (1984) paper tried to find how people weight technological risks against benefits. Starr proposed that people would arrive at a balance between the risks and benefits associated with new technologies. Researchers followed this approach for many years to conduct studies of risk perception (Slovic 2000). Such research included two main features. One applied respondents' ratings of "personalities of hazards" on various characteristics that had been assumed to influence risk perceptions and acceptance. The other used psychometric scaling methods to create quantitative measures of perceived risk and perceived benefit. The psychometrics paradigm framework refers to numerical rating scales supplemented with traditional attitude questions and non-traditional word association and scenario

generation methods (Slovic 2000, xxxiii). "In sum, the psychometrics paradigm encompasses a theoretical framework that assumes risk is subjectively defined by individuals who may be influenced by a wide array of psychological, social, institutional and cultural factors. The paradigm assumes that, with appropriate design of survey instruments, many of these factors and their interrelationships can be quantified and modeled in order to illuminate the responses of individuals and their societies to the hazards that confront them" (Slovic 2000, xxiii). The theory of the psychometrics paradigm is argued to have some limitations, since it assumes that people can provide answers to some difficult questions, and the questions asked are about feelings, rather than actual behaviors (Slovic 2000).

Cultural theory has also been applied in risk perception research. The cultural theory of risk is able to "predict and explain what kind of people will perceive which potential hazards to be how dangerous" (Wildavsky and Dake 1990, p. 42). According to this theory, risk perception is closely related to which group one belongs to, and is determined by cultural adherence and social aspects (Wildavsky and Dake 1990). Wildavsky and Dake categorized respondents as 'individualists', 'hierarchists' or 'egalitarians' according to their responses to a set of questions relating to political attitudes. These authors categorized respondents as 'individualists', 'hierarchists' or 'egalitarians' according to their responses to a set of questions relating to political attitudes. Statistically significant correlations between cultural biases and social perceptions of risk were found. They conclude: "In summary, the great struggles over the perceived dangers of technology in our time are essentially about trust and distrust of societal institutions, that is, about cultural conflict. Once we vary the object of concern, we do indeed discover that egalitarians (who fear social deviance less than hierarchists and individualists) fear technology a great deal—seeing in it, or so the cultural theory claims, the corporate greed they believe leads to inequality. Individualists, who believe in competition, and who are exceedingly loath to placing restraints on what they consider to be mutually profitable relationships, deem technology to be good. In contrast, hierarchists, who fear disorder and erosion of status differences, are more worried about social deviance and less worried about technological dangers than egalitarians." (Wildavsky and Dake 1990, pp. 56-57)

3.6 Selected Economic Concepts Relating to Food Safety

3.6.1 Public Goods Concepts

Public goods can be consumed by an individual without reducing the amount available for others, which is called its "non-rival" characteristic (i.e. non-rivalry in consumption). Another characteristic of a public good relates to its "non-excludability." Ng (1979) notes national defense as an example: many individuals can benefit from national defense, while it is difficult to exclude others from benefiting from this. In contrast, individuals can purchase and consume private goods, such as food, and these goods do not exhibit the two characteristics noted above which can be used to distinguish between public goods and private goods (Ng 1979, Walter 1983). Basic levels of food safety and public health can be viewed as public goods. Foods that are defined as meeting quality characteristics that exceed the levels needed for basic food safety would not be classified as public goods.

3.6.2 Information Attributes of Goods

A credence good can be defined as a good whose quality is difficult or impossible for the consumer to ascertain. The term "credence" was first proposed by Darby and Karni (1973). Based on Nelson (1970), Darby and Karni (1973) pointed out three types of characteristics associated with consumer purchases. These three qualities are "search qualities", "experience qualities" and "credence qualities":

"Search qualities" have low cost, letting consumers discover the quality of the good before purchase. Purchase is not necessary to decide quality in "search". "Experience qualities" are obtained after purchase of the goods; thus purchase of the goods is required. "Credence qualities arise whenever a good is utilized either in combination with other goods of uncertain properties to produce measurable output or in a production process in which output, at least in a subjective sense, is stochastic, or where both occur." (Darby and Karni 1973, p. 69)

An example of "credence qualities" is given by Darby and Karni (1973): "A consumer cannot fully evaluate the repair of a malfunctioning durable good or human being, since he is unfamiliar with the intricacies and peculiarities of the particular

machine. Due to lack of knowledge of the inputs of repair services required to maintain given flows of ultimate services from a commodity, the consumer must purchase both information and repair services." (Darby and Karni, 1973, p. 69). Another example of "credence goods" is provided by particular food claims, such as non-inclusion of genetically modified (GM) food. This arises since the presence or absence of GM food may have uncertain ecological and health effects in the long run (Baksi and Bose 2007), but such affects are not known to the user even after purchase and consumption.

3.6.3 Market Failure and Food Safety

Food safety is an important component of the attributes of food. This attribute is quite different from many others, because food safety typically cannot be easily measured before purchase but can be viewed as encompassing both "consumption" and "credence" attributes. From a broad viewpoint, food safety can include nutritional quality, chemical and microbiological safety and concerns regarding particular food and food processes. Concerns about these features can decrease consumption of food (Ritson and Mai, 1998).

Ritson and Mai (1998) reviewed reasons why a market economy may be in "failure" in its ability of provide an optimum degree of food safety. They list four factors, of which the first is: "Asymmetry in knowledge of risk" (Ritson and Mai, 1998, p.255). This arises since producers always know better than consumers about certain food properties potentially associated with a safety risk. Two common ways to help reduce the asymmetry in knowledge of risk are, government regulation, (essentially prohibiting the marketing of foods containing certain characteristics), and legislation to improve labeling.

The second feature outlined by Ritson and Mai (1998, p.255) is "Food safety as a public good." Food safety can be seen as having public good characteristics relating to non-excludability and indivisibility. For example, providing systems of management that enhance public health through safe food and water can benefit many consumers and it would be difficult to impose exclusion from these benefits.

A third issue noted by Ritson and Mai (1998, p.255) is "Social costs and benefits." Social costs of food-borne diseases involve tangible and intangible costs. The final issue noted by these authors is "Divergence between perceived and real risk"

(Ritson and Mai 1998, p.255). As discussed above there is often a wide divergence between perceived risk and objectively measured scientific risk.

3.6.4 Incorporating Risks into the Theory of Consumer Behavior

Economists use expected utility theory (EUT) to analyze consumer behavior under risk. Expected utility theory is the standard foundation for risk and uncertainty analysis in economics. Von Neumann and Morgenstern (1944) first explicitly determined utility value in the form of a mathematical function. Following Von Neumann and Morgenstern (1944), the theory states that the decision maker (DM) chooses between risky or uncertain prospects by comparing their expected utility values. Assuming that the initial income is M and the magnitude of risk events can be represented by the value of random losses A (income uncertainty) whose distribution is independent of X, U(X) is the utility associated with X; EV is the expected utility. The expected indirect utility function of consumers can be shown as:

$$\{EV = EV(P, M - A) : V(P, M - A) = \{MaxU(X), PX = M - A\}, A \sim F(A)\}$$

$$\Rightarrow EV \approx V(P, M) + E(A)V_M'(P, M) + \frac{Var(A)}{2}V_{M^2}''(P, M)$$

The utility function is based on several axioms. These are the requirements for preferences to exhibit: 1.Completeness and Transitivity; 2. Betweeness; 3 Independence; 4 Monotonicity; 5 Reducibility (Von Neumann and Morgenstern 1944). An example of this approach is given by Antle (2001) in which environment-related health risks are incorporated in an overview of food safety issues. In Antle's model, the consumer's utility function is associated with risky food, risk-less food, health status and medical expenditures. Expected utility is expressed as a function of consumption of risk food, risk-less food and the household's subjective distribution of health (Antle 2001). A drawback of the EUT theory is that it assumes there is accurate information about food risks, which is not always true in the real world. Another limitation of this theory is that violations of axioms are found in some studies (Dubra et al., 2004, Machina 1982). Criticisms have arisen from observations that consumer behavior may be governed by qualitative or perceived risks rather than by expected utility theory.

4 THE DATA

4.1 Introduction to the 2003 Survey

The first part of the data in this research was collected in January 2003 by an online survey developed by Michele Veeman, Wiktor Adamowicz and Anna Huennemeyer of the Department of Rural Economy at the University of Alberta. A professional survey company was recruited to administer this to a sample drawn from a representative consumer panel of more than 40,000 households in Canada. In total 882 respondents successfully completed questionnaires.

The survey contained 26 questions divided into three parts, one of which focused on consumers' attitudes towards food and environment risks. This provides data used in this study. These questions were:

"**Q6.** Below is a list of possible **food safety** issues. For each, please indicate how much of a health risk you feel it is to you personally." The order of issues was randomized in the survey and respondents were asked to indicate for each whether this was: High risk; Moderate risk; Slight risk; Almost no risk; don't Know /Not Sure. The issues queried were:

A) Bacteria contamination of food
B) Pesticide residual in foods
C) Use of hormones in food production
D) Use of antibiotics in food production
E) BSE (mad cow disease)
F) Use of food additives
G) Use of genetic modification/ engineering in food production
H) Fat and cholesterol content

Another question was:

"**Q7.** We would like to get your opinion on possible **environmental safety** issues that might result from modern agriculture. Please indicate how much of a risk to the environment you personally believe each issue represents." Again the order of issues is randomized in the survey. The queried issues were:

A) Water pollution by chemical run-offs from agriculture

B) Soil erosion through agricultural activity

C) Genetic modification/ engineering

D) Resistance to herbicides and pesticides

E) Adverse effects of agriculture on biodiversity

F) Agricultural waste disposal (e.g., animal manure)

The survey also collected socio-economic and demographic information. Information on the respondent's gender, age, the number of members living in household, the number of children, education level, employment status, household income, frequency of buying organic food and the place of residence was collected.

4.2 Description of the 2003 Survey Data

The survey data are described in Table 4-1.Comparison of the characteristics of sample data with those estimated by Statistics Canada for the Canadian population (Table 4-2) indicates that the female population is slightly over-represented (sample, 55.9%; Canadian population 50.5%). However, considering that women are responsible for much food shopping and preparation, the sample data is considered to be acceptable. The sample data is skewed to respondents with higher education levels. The survey sample has a higher percentage with a university degree.

The employment status of those in the sample is fairly representative of the Canadian population. The total household income before tax of the sample data is slightly higher than reported for the Canadian population. One possible reason is that the survey was conducted on line, those with higher income are more likely to afford computer and Internet access. The sample data slightly over-represents those with higher incomes.

For the distribution of geographical residence, the sample data well represents the Canadian regional population distribution. The sample data over-represents the older population (sample age median =43; Canadian national age median=37).

Generally speaking, comparison of the demographic and economic characteristics of the survey sample with those for the Canadian population, as shown by Table 4-2, suggests that the survey sample may be considered as reasonably representative of the Canadian population.

Table 4-1 2003 Survey Data Description (N=882)

Variable	Measurement	Mean	Std.	Min.	Max
TGOV	Trustworthy: Canadian government. 1-trust, 0-not trust	0.60	0.49	0	1
TFOOD	Trustworthy: food industry. 1-trust, 0-not trust	0.40	0.49	0	1
TFARM	Trustworthy: farmers' assoc.1-trust, 0-not trust	0.60	0.49	0	1
TFAMIL	Trustworthy: family 1-trust, 0-not trust	0.49	0.50	0	1
TRESEA	Trustworthy: research inst. 1-trust, 0-not trust	0.91	0.29	0	1
TCONS	Trustworthy: consumer assoc. 1-trust, 0-not trust	0.87	0.34	0	1
AGE	Age is years	44.46	13.44	18	79
MALE	1-male; 0-female	0.42	0.49	0	1
CHILD	Number of children in household	0.79	1.12	0	6
UNIVER	1-university degree or graduate, 0-less than university degree	0.36	0.48	0	1
EMPLOY	Employment status, 1-working full or part time, 0 -otherwise	0.61	0.49	0	1
INCOME	Total household income before taxes. 2-10,000-19,999; 3-20,000-29,999; 4-30,000-39,999; 5-40,000-49,999; 6- 50,000-59,999; 7- 60,000-69,999; 8- 70,000-79,999; 9- 80,000-89,999; 10-90,000-99,999; 11-More than $100,000	6.32	2.66	1	11
BORG	1-often buy organic food; 0-occasionally or almost never buy organic food	0.09	0.29	0	1
BC	1-resident of British Columbia, 0-otherwise	0.11	0.31	0	1
PRAIRIE	1-resident of Alberta, Saskatchewan or Manitoba, 0-otherwise	0.13	0.34	0	1
ON	1-resident of Ontario, 0-otherwise	0.40	0.49	0	1
QC	1-resident of Quebec, 0-otherwise	0.29	0.45	0	1

Table 4-2 Comparisons of 2003 Survey Sample with Canadian Population Statistics[a]

Variable	measurement	2003 Sample	2003 Canadian
male	male	44.10%	49.5% [1]
female	female	55.90%	50.5%
no univer	Those who do not have university degree	61.90%	82.05%[2]
univer	Those who have university degree	38.10%	17.95%
no employ**	Those who do not work full-time or part-time	37.20%	38.52%[3]
employ	Those who work full time or part time	62.40%	61.48%
Income	The total family income	Median=66532	Median=56000[4]
BC	Resident of British Columbia	10.80%	13.12%[5]
PRAIRIE	Resident of Alberta, Saskatchewan or Manitoba	13.0%	16.79%
ON	Resident of Ontario	38.90%	38.71%
QC	Resident of Quebec	29.40%	23.66%
ALANTIC	Resident of Atlantic Provinces (New Brunswick, Newfoundland, Nova Scotia, Prince Edward Island	7.90%	7.4%
TERRITORY	Resident of Territory Provinces	0.00%	0.32%
AGE		Median=43	Median=37

a. Survey respondents' self-reported employment status may differ from the definitions used by Statistics Canada.

1. http://www40.statcan.ca/l01/cst01/demo10a.htm?sdi=population
2. http://www40.statcan.ca/l01/cst01/educ41a.htm?sdi=graduation
3. http://www40.statcan.ca/l01/cst01/econ10.htm?sdi=employed
4. http://www40.statcan.ca/l01/cst01/famil108a.htm?sdi=income
5. http://www40.statcan.ca/l01/cst01/demo02a.htm?sdi=population%20province

4.3 Introduction to the 2005 Survey

Data for the second part of this study were collected in October 2005 from a study of public opinions on modern agriculture and food. This survey was conducted by Michele Veeman and Wiktor Adamowicz. It was also computer-based. Another market research company was responsible for the data collection, again from a representative marketing panel. Similar attitudinal questions were asked in this study. The questions are as follows:

"Q2. Please indicate the risk that you believe applies to each of the issues listed below"

High risk; Moderate risk; Slight risk; Almost no risk; Don't know/ unsure

A) Bacteria contamination of food

B) Pesticide residuals in food

C) Use of hormones in food production

D) Use of antibiotics in food production

E) Genetically modified/engineered crops to increase crop production

F) Drugs (i.e., medicine) made from plant molecular farming through genetic modification/ engineering

G) Genetically modified/engineered crops to increase nutritional qualities of food

H) Genetically modified/engineered crops to produce industrial products lick plastics, fuel or industrial enzymes

I) BSE (mad cow disease)

J) Use of food additives

K) Fat and cholesterol content of food

"Q3. We would also like to have your opinion on possible environmental safety issues that may result from modern agriculture. Please indicate the risk that you believe applies to each issue."

High risk; Moderate risk; Slight risk; Almost no risk; Don't know/ unsure

A) Water pollution by chemical run-off from agriculture

B) Use of genetically modified/engineered crops to increase crop production

C) Use of genetically modified/engineered crops for drug (i.e., medicine) production

D) Use of genetically modified/engineered crops to increase nutritional qualities of food

E) Use of genetically modified/engineered crops for industrial products like plastics, fuel or industrial enzymes

F) Agricultural waste disposal (e.g., animal manure disposal)

G) Soil erosion from agricultural activity

H) Use of herbicides and pesticides

I) Adverse effects of agricultural on biodiversity

The 2005 survey subsequently mainly focused on issues associated with public research funding allocations. Social-economic and demographic information was also sought from respondents.

4.4 Description of the 2005 Survey Data

The description of respondents in the data sample collected in 2005 is given in Table 4-3. Comparison of major demographic variables between 2005 survey sample and the Canadian national population can be made from Table 4-4.

The sample gender distribution fairly captures the national characteristic. However, the sample data somewhat over- represents those with higher education levels. Employment status seems to reasonably well represent the employment status of the Canadian population. The average total household income before tax in the sample data set is $55,600, which is slightly lower than that reported by Statistics Canada ($60,600). The distribution of residence by province and territory reasonably represents the Canadian distribution of residence. The average age of the sample is somewhat younger than the median age of Canadian population.

Comparison of the characteristics of the 2005 survey data with the Canadian population suggests that the survey sample is reasonably representative of the Canadian population.

Table 4-3 2005 Survey Data Description (N=1574)

Variable	Measurement	Mean	Std.	Min	Max
MALE	1-male; 0-female	0.49	0.5	0	1
AGE	Age in years	43.53	14.73	18	82
CHILD	Number of children in household	0.73	1.21	0	10
UNIVER	1-university degree or graduate, 0-less than university degree	0.24	0.43	0	1
EMPLOY	Employment status, 1-working full or part time, 0 - otherwise	0.6	0.49	0	1
INCOME	Total household income before taxes. 2-10,000-19,999; 3-20,000-29,999; 4-30,000-39,999; 5-40,000-49,999; 6- 50,000-59,999; 7- 60,000-69,999; 8- 70,000-79,999; 9- 80,000-89,999; 10-90,000-99,999; 11-More than $100,000	5.56	2.63	1	11
BC	1-resident of British Columbia; 0-otherwise	0.12	0.33	0	1
PRAIRIE	1-resident of Alberta, Saskatchewan or Manitoba; 0-otherwise	0.17	0.38	0	1
ON	1-resident of Ontario; 0-otherwise	0.39	0.49	0	1
QC	1-resident of Quebec; 0-otherwise	0.25	0.43	0	1
ATLAN	1-resident of Atlantic Provinces(New Brunswick, Newfoundland, Nova Scotia, Prince Edward Island) ; 0-otherwise	0.07	0.25	0	1
TFRIEND	Trustworthy: friend and family. 1-trust, 0-not trust	0.07	0.26	0	1
TNEWS	Trustworthy: newspaper and magazines. 1-trust, 0-not trust	0.22	0.42	0	1
TRADIO	Trustworthy: radio and TV. 1-trust; 0-not trust	0.14	0.35	0	1
TINTER	Trustworthy: The internet. 1-trust, 0-not trust	0.5	0.5	0	1
TDOCTOR	Trustworthy: doctor. 1-trust, 0-not trust	0.18	0.38	0	1
TUNIVER	Trustworthy: university. 1-trust, 0-not trust	0.53	0.5	0	1

Table 4-4 Comparisons of 2005 Survey Sample with Canadian Population Statistics[a]

Variable	Measurement	2005 Sample	2005 Canadian
MALE	male	48.80%	49.5%[1]
FEMALE	female	51.20%	50.5%
NO UNIVER	Those who do not have university degree	76.10%	82%[2]
UNIVER	Those who have university degree	23.90%	18%
NO EMPLOY	Those who do not work full-time or part-time	39.70%	37.3%[3]
EMPLOY	Those who work full time or part time	60.30%	62.70%
Average income	Total household income before taxes 2-10,000-19,999; 3-20,000-29,999; 4-30,000-39,999; 5-40,000-49,999; 6- 50,000-59,999; 7- 60,000-69,999; 8- 70,000-79,999; 9- 80,000-89,999; 10-90,000-99,999; 11-More than $100,000	Median=45000	Median=60600[4]
BC	Resident of British Columbia	12.30%	13.05%[5]
PRAIRIE	Resident of Alberta, Saskatchewan or Manitoba	17.30%	16.9%
ON	Resident of Ontario	38.60%	38.08%
QC	Resident of Quebec	24.90%	24.04%
ALANTIC	Resident of Atlantic Provinces (New Brunswick, Newfoundland, Nova Scotia, Prince Edward Island	6.80%	7.62%
TERRITORY	Resident of Territory Provinces	0.10%	0.31%
AGE	Age in years	Median=40	Median=37

a. Survey respondents' self-reported employment status may differ from the definitions used by Statistics Canada.

1. http://www40.statcan.ca/l01/cst01/demo10a.htm?sdi=population
2. http://www40.statcan.ca/l01/cst01/educ41a.htm?sdi=graduation
3. http://www40.statcan.ca/l01/cst01/econ10.htm?sdi=employed
4. http://www40.statcan.ca/l01/cst01/famil108a.htm?sdi=income
5. http://www40.statcan.ca/l01/cst01/demo02a.htm?sdi=population%20province

Table 4-5 gives the summary statistics for respondents' food safety ratings from the 2003 survey. The most risky issue cited (judged by the percentage of those who gave this a "high risk" response) is pesticide residuals (41%), followed by bacteria contamination (40.8%), use of antibiotics (35.6%), BSE (mad cow disease) (31.7%), use of hormones (31.6%), fat and cholesterol (24.9%), use of GM/GE (20.7%) and food additives (14.6%).

Table 4-6 shows the percentages of respondents who chose ratings for the various food safety issues in the 2005 survey. The order (judged according to those who chose "high risk" ratings) is use of hormones (33.4%), use of antibiotics (31.3%), fat and

cholesterol (30.5%), pesticide residuals (29.2%), use of GM/GE in crop production (28.6%), food additives (25.1%), BSE (mad cow disease) (24.1%) and bacteria contamination (18.4%). Compared to the 2003 survey responses, the issue of use of hormones moved from 5 to 1 (according to the order of the percentage of respondents who cited each issue as "high risk").). The issue of fat and cholesterol moved from number 6 to 3. Bacteria contamination moved from number 2 to 8. BSE (mad cow disease) moved from number 2 to 7. The data show that respondents tended to rate the use of hormones, use of antibiotics and fat and cholesterol as being most risky in 2005 survey; overall, fewer chose a " high risk" rating for BSE (mad cow disease) and bacteria contamination in 2005 than in 2003. A graphic representation of the changes in the various risk ratings is given in Figures 4.1 to 4.8

Figure 4-1 illustrates the risk ratings in 2003 and 2005 for the issue of bacteria contamination. As seen from Table 4-6 and shown in Figure 4-1, the proportion of those rating this as "high risk" decreased from 40.8% (2003) to 18.4% (2005); those rating this as a "moderate risk" increased from 23.1% (2003) to 36% (2005) and the rating of "slight risk" increased from 22.6% (2003) to 35.3% (2007).

Figure 4-2 depicts the risk ratings for the issue of pesticide residuals in 2003 and 2005. The tendency for change in risk ratings is similar to that shown Figure 4-1. The proportion of those rating this as "high risk" dropped from year 2003 to 2005, while the proportion of those giving a rating of "moderate risk" and "slight risk" rose from year 2003 to 2005.

The descriptive data in Figure 4-3 suggest no major change in the "high risk" rating for the issue of use of hormones between two years. As indicated in Tables 4-5 and 4-6, the proportion of those giving a rating of "moderate risk" changed slightly from 28.5% (2003) to 34.4 % (2005). Generally speaking, respondents gave similar risk ratings to the use of hormones in each of the two years.

Figure 4-4 depicts risk ratings for 2003 and 2005 for the use of antibiotics. In these years, the proportion giving this a "high risk" rating decreased from 35.6 % (2003) to 31.3 % (2005), while those giving a "moderate risk" rating increased from 23.5% (2003) to 31.6% (2005).

The proportion of respondents giving a "high risk" rating for food to BSE (mad cow disease) decreased from 31.7% (2003) to 24.1% (2005). There was a decrease in the "almost no risk" rating from 35.5% (2003) to 18.6% (2005). However, responses of "moderate risk" increased from 11% (2003) to 26.7% (2005), and the "slight risk" ratings increased from 17.6% (2003) to 28.4% (2005) of respondents.

From Figure 4-6, it is seen that the percentage of respondents giving a "high risk" rating increased from 14.6% (2003) to 25.1% (2005), while the "almost no risk" rating decreased from 16.2% (2003) to 7.9% (2005). The "moderate risk" and "slight risk" rating proportions are almost the same in the two years.

Comparison of the risk ratings for use of GM/GE in crop production between 2003 and 2005 is illustrated in Figure 4-7. The percentage of those giving this a "high risk" rating changed from 20.7% (2003) to 28.6% (2005), while the "almost no risk" ratings fell from 21.5% (2003) to 13.1% (2005).

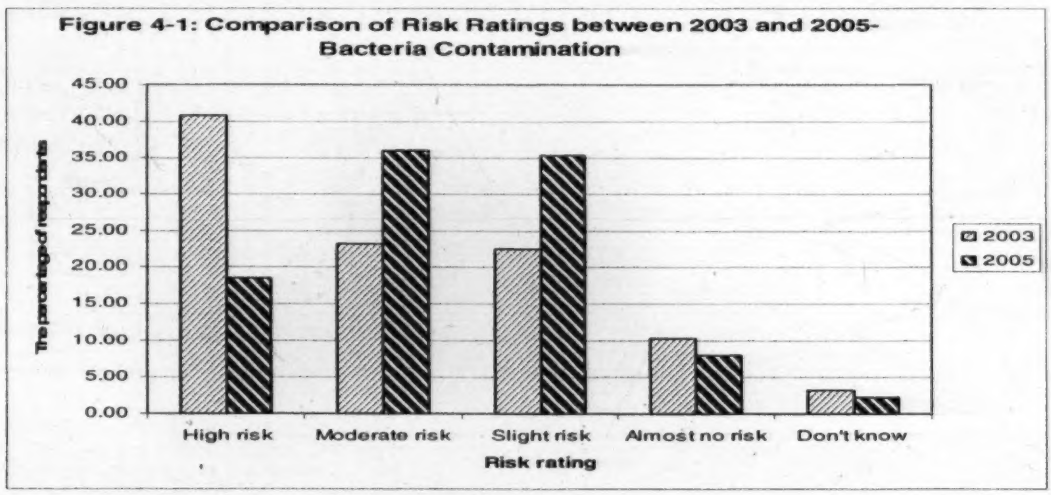
Figure 4-8 shows the responses to the issue of fat and cholesterol in food. It can be seen that the percentage giving a "high risk" " rating increased from 24.9% (2003) to 30.5% (2005). A smaller proportion of respondents saw this as a moderate risk in 2005. .

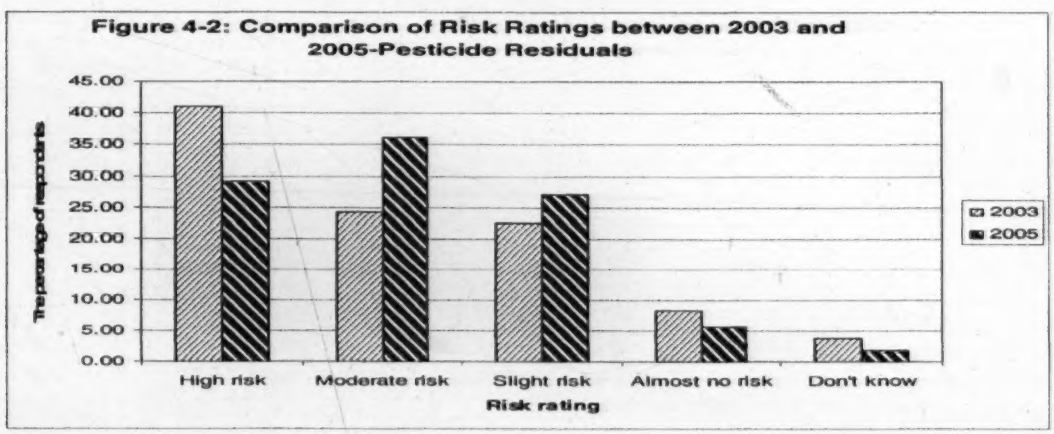
Table 4-5 Summary Statistics for the Food Safety Ratings 2003 (Percentage of responses; N=882)

	Issues	High risk	Moderate risk	Slight risk	Almost no risk	Don't know
1	Pesticide residuals	41	24.4	22.4	8.3	3.9
2	Bacteria contamination	40.8	23.1	22.6	10.2	3.3
3	Use of antibiotics	35.6	23.5	22.3	10.8	7.8
4	BSE (mad cow disease)	31.7	11	17.6	35.5	4.2
5	Use of hormones	31.6	28.5	23.5	9.5	6.9
6	Fat and cholesterol	24.9	39.9	24.5	9.6	1
7	Use of GM/GE	20.7	22.2	27.8	21.5	7.7
8	Food additives	14.6	31.5	34.8	16.2	2.8

Table 4-6 Summary Statistics for Dependent Variables of Food Safety Ratings 2005 (Percentage of responses; N=1574)

	Issues	High risk	Moderate risk	Slight risk	Almost no risk	Don't know
1	Use of hormones	33.4	34.4	21.2	6.5	4.6
2	Use of antibiotics	31.3	31.6	22.7	8	6.3
3	Fat and cholesterol	30.5	37	24.3	6.3	1.9
4	Pesticide residuals	29.2	36.1	27.2	5.7	1.8
5	Use of GM/GE in crop production	28.6	27.9	26	13.1	4.4
6	Food additives	25.1	33.4	30.8	7.9	2.7
7	BSE (mad cow disease)	24.1	26.7	28.4	18.6	2.2
8	Bacteria contamination	18.4	36	35.3	8	2.3





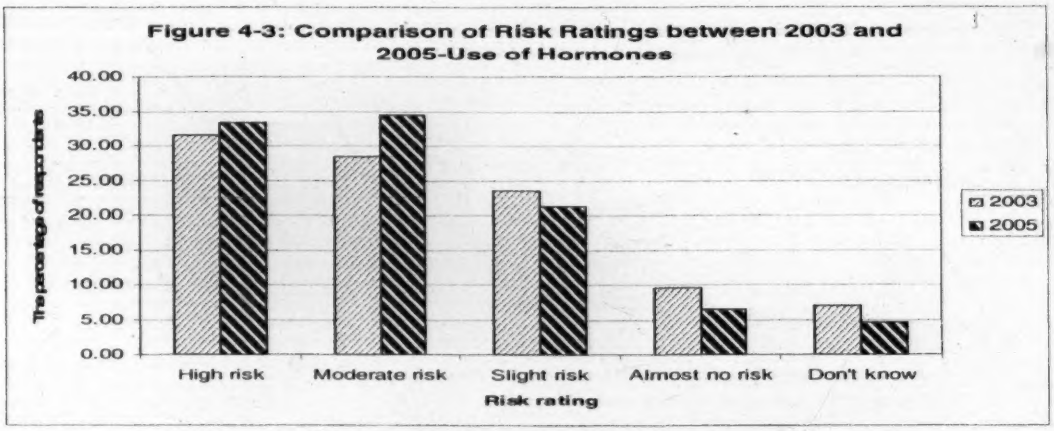


Figure 4-3: Comparison of Risk Ratings between 2003 and 2005-Use of Hormones
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
High risk
Moderate risk
Slight risk
Almost no risk
Don't know
Risk rating
2003
2005

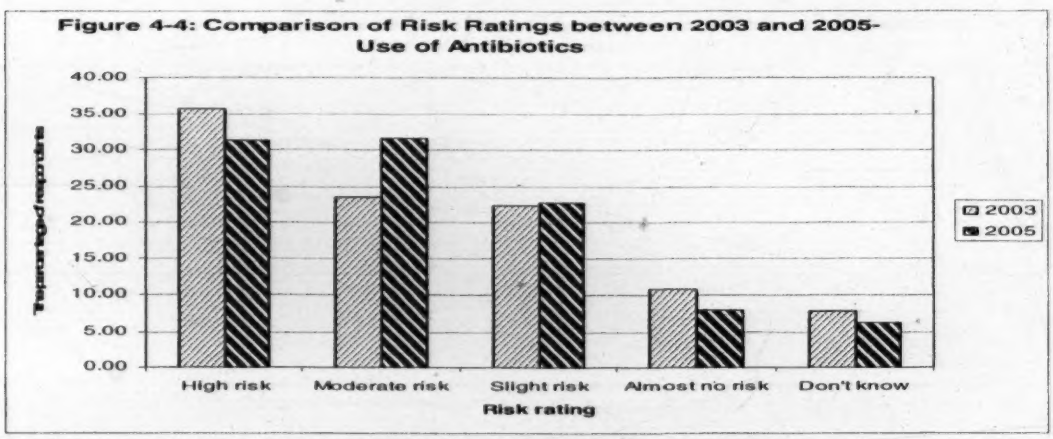


Figure 4-4: Comparison of Risk Ratings between 2003 and 2005-Use of Antibiotics
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
High risk
Moderate risk
Slight risk
Almost no risk
Don't know
Risk rating
2003
2005

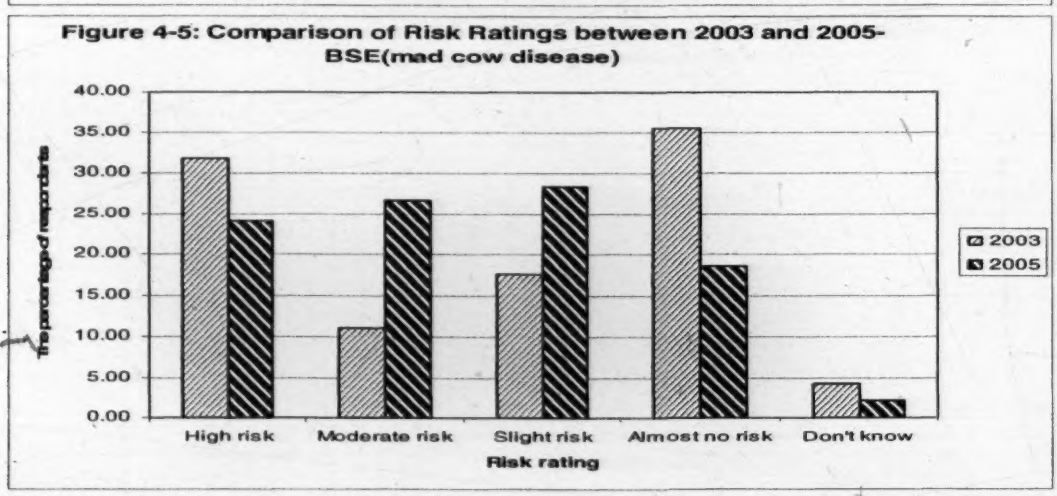
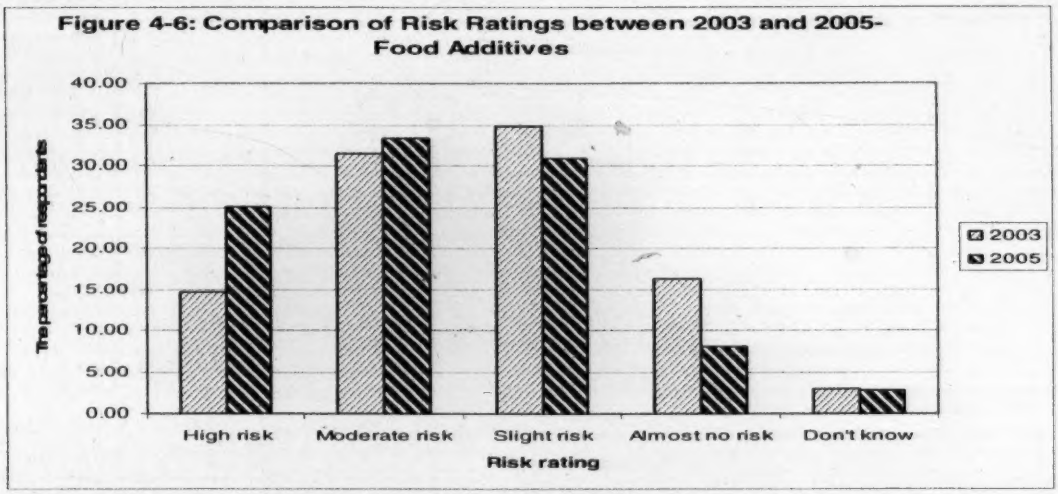
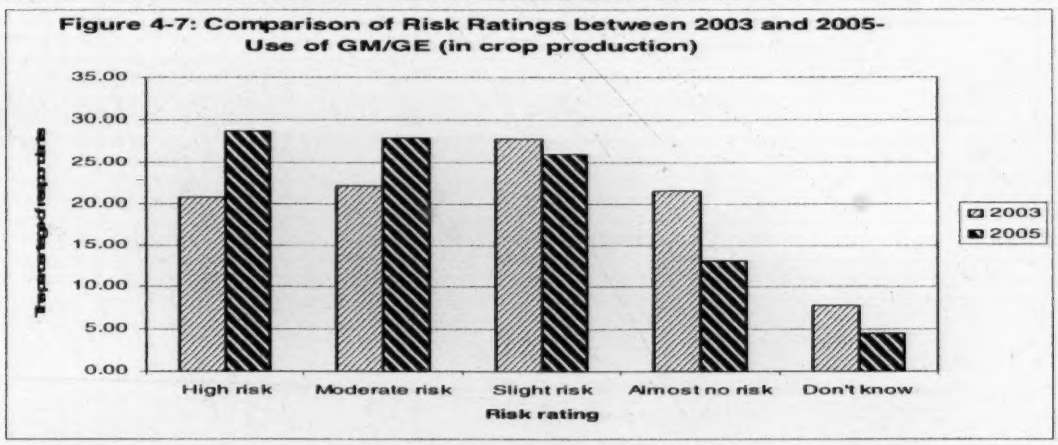
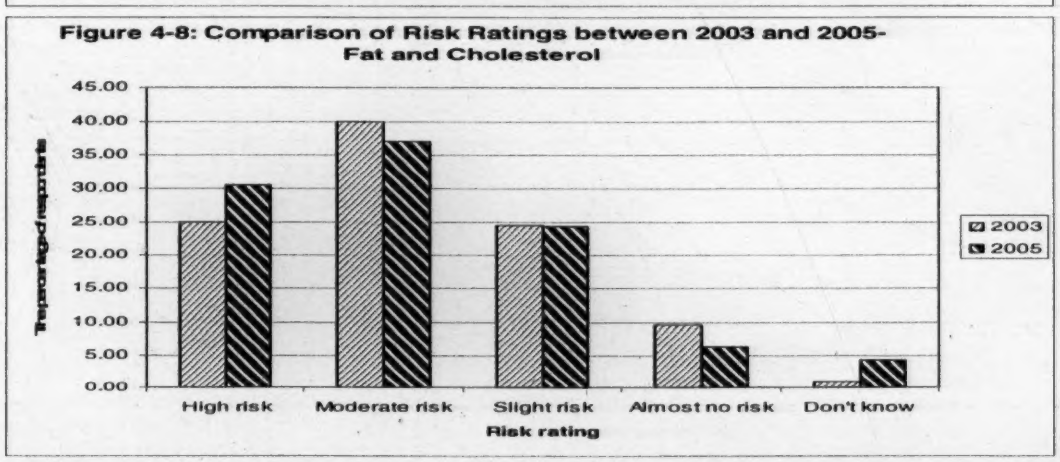


Figure 4-5: Comparison of Risk Ratings between 2003 and 2005-BSE(mad cow disease)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
High risk
Moderate risk
Slight risk
Almost no risk
Don't know
Risk rating
2003
2005







The order of concerns given by the percentages of those who rated "high risk" for environment safety in 2003 is shown in Table 4-7. The issue of water pollution is rated to

be the most risky (this was rated as high risk by 61.3% of respondents), followed by resistance to herbicide & pesticides (50.2%), agricultural waste disposal (40.8%), soil erosion (27.9%), GM/GE effects on the environment (27.1%), and adverse effects on biodiversity (25.5%).

The percentages of respondents who chose the various risk ratings in 2005 is presented in Table 4-8. In order, the most risky issues are seen as water pollution (47.6% viewed this as high risk), resistance to herbicide & pesticides (46.8%), waste disposal (26.5%), soil erosion (24.1%) GM/GE on environment (23.3%), adverse effects on biodiversity (21.6%). Adverse effects on biodiversity changed from the 4th to the 6th most risky issue in 2005 based on this criteria. The comparable order of the other issues remained the same. A graphical depiction of the changes in ratings is in Figures 4.9 to 4.14.

Comparison of 2003 and 2005 responses for the issue of water pollution is shown in Figure 4-9; the percentage of respondents giving this a "high risk" rating decreased from 61.3% (2003) to 47.6% (2005), while the percentage citing "moderate risk" increased from 27.9% (2003) to 35.2% (2005).

Figure 4-10 depicts the differences between 2003 and 2005 for the issue of soil erosion. The percentage of "high risk" responses changed from 27.9% (2003) to 24.1% (2005). From Figure 4-10, respondents showed a generally similar pattern of ratings for "moderate risk", "slight risk", "almost no risk" and "don't know" in the year 2003 and 2005.

Relative to the issue of the effects of GM/GE in agriculture on the environment, Figure 4-11 illustrates the change of percentage of responses in 2003 and 2005. The percentage of "high risk" responses decreased from 27.1% (2003) to 23.3% (2005), while the percentage of those giving "moderate risk" ratings increased from 29% (2003) to 34.2% (2005).

Figure 4-12 shows the risk ratings in 2003 and 2005 for the issue of environmental risk from resistance to herbicides and pesticides. It can be seen that the respondents gave similar ratings in the two years.

Figure 4-13 shows responses for adverse effects of agriculture on biodiversity: the percentage of responses giving "moderate risk" decreased from 36.2% (2003) to

32.2% (2005), while the percentage of "slight risk" ratings increased from 21.7% (2003) to 28.6% (2005).

Figure 4-14 illustrates risk ratings in 2003 and 2005 for agricultural waste disposal. As shown in this graph, the percentage of "high risk" responses dropped from 40.8% (2003) to 26.5% (2005), while the percentage of "slight risk" ratings increased from 17.2% (2003) to 25.7% (2005).

Table 4-7 Summary Statistics for the Environmental Safety Ratings 2003 (Percentage of responses; N=882)

	Issues	High risk	Moderate risk	Slight risk	Almost no risk	Don't know
1	Water pollution	61.3	27.9	7.7	1.9	1.2
2	Resistance to herbicide& pesticides	50.2	31.9	13.2	1.8	2.9
3	Agricultural waste disposal	40.8	32.2	17.2	8.3	1.5
4	Soil erosion	27.9	37.2	26.2	5.1	3.6
5	GM/GE of environment	27.1	29	24.3	12.9	6.7
6	Adverse effects on biodiversity	25.5	36.2	21.7	5.6	11

Table 4-8 Summary Statistics for Environmental Safety Ratings 2005 (Percentage of responses; N=1574)

	Issues	High risk	Moderate risk	Slight risk	Almost no risk	Don't know
1	Water pollution	47.6	35.2	14	2	1.2
2	Resistance to herbicide & pesticides	46.8	34.2	15.2	2.5	1.3
3	Agricultural waste disposal	26.5	33.5	25.7	11.9	2.4
4	Soil erosion	24.1	36.3	28.5	8.1	3
5	GM/GE on environment	23.3	34.2	26.2	11.5	4.8
6	Adverse effects on biodiversity	21.6	32.2	28.6	6.8	10.8

Figure 4-9: Comparison of Risk Ratings between 2003 and 2005-Water Pollution

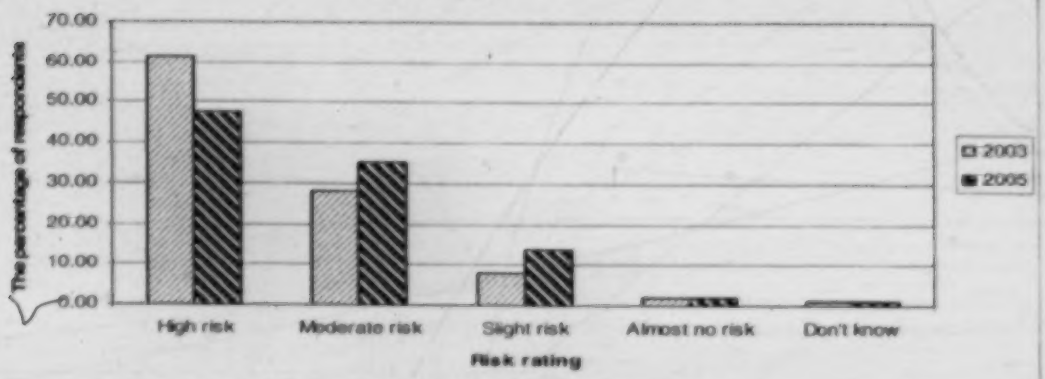


Figure 4-10: Comparison of Risk Ratings between 2003 and 2005-Soil Erosion

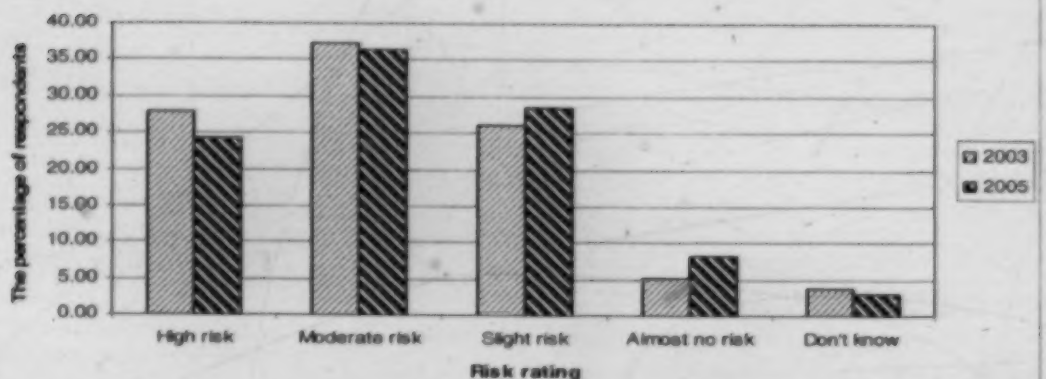


Figure 4-11: Comparison of Risk Ratings between 2003 and 2005-GM/GE(on environment)

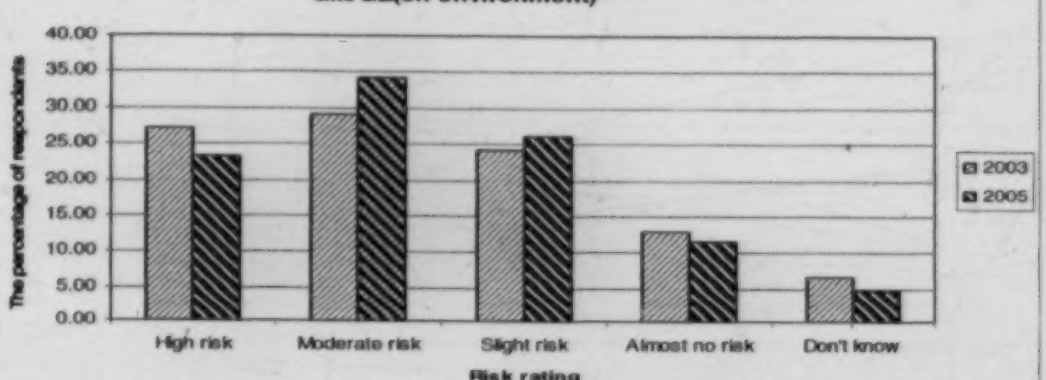


Figure 4-12: Comparison of Risk Ratings between 2003 and 2005- Resistance to Herbcides and Pesticides

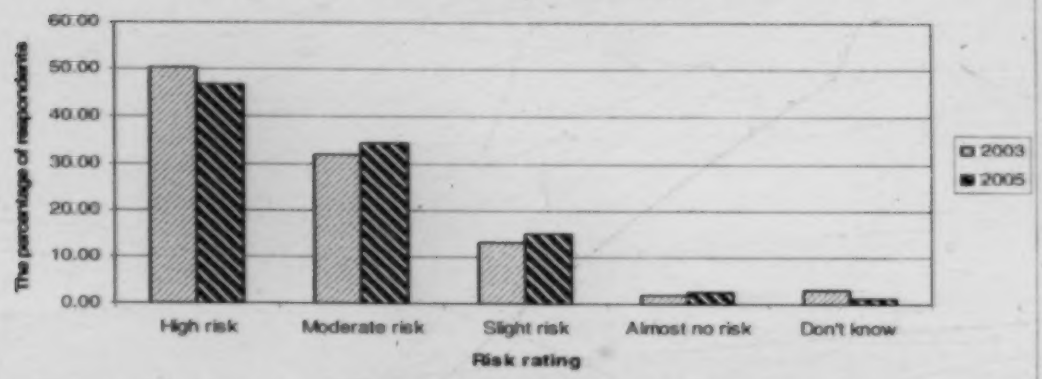


Figure 4-13: Comparison of Risk Ratings between 2003 and 2005- Adverse Effects on Biodiversity

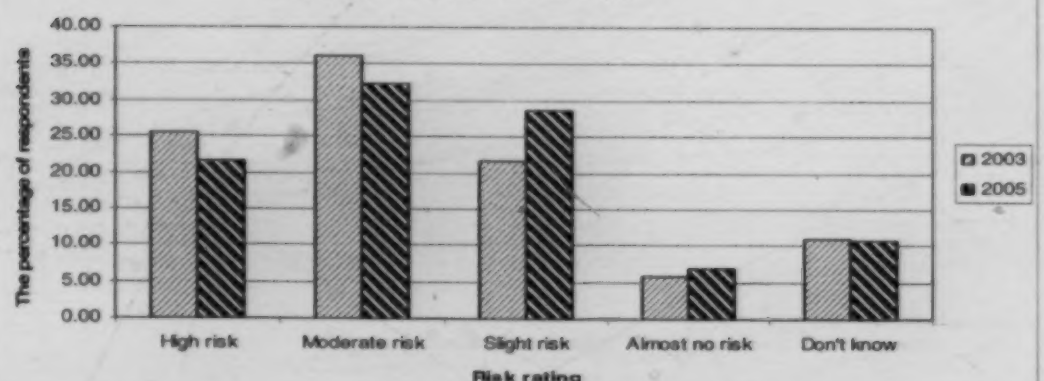
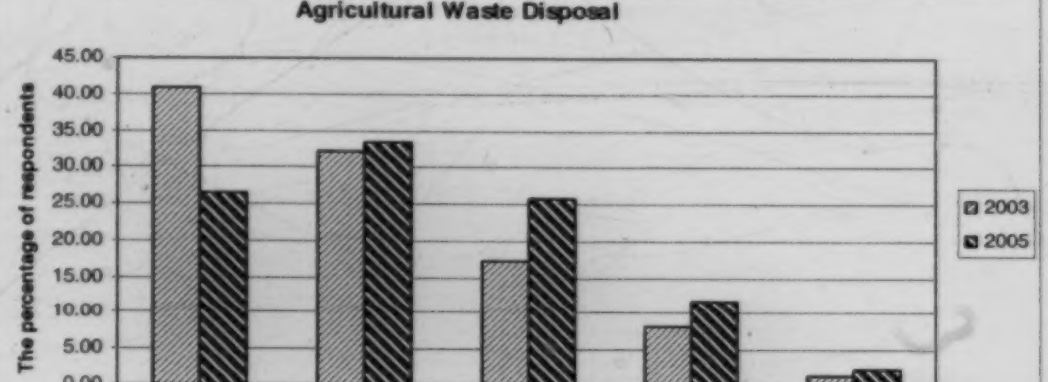


Figure 4-14: Comparison of Risk Ratings between 2003 and 2005- Agricultural Waste Disposal



4.5 K-S Tests of Differences in Risk Ratings between 2003 and 2005

The Kolmogorov-Smirnov test (K-S test) tries to determine if two datasets differ significantly. The non-parametric test is based on the maximum difference between an empirical and a hypothetical cumulative distribution. As described in Massey (1951),

Suppose that a population is thought to have some specified cumulative frequency distribution function, say $F_0(X)$ *That is, for any specified value of x, the value of* $F_0(X)$ *is the proportion of individuals in the population having measurements less than or equal to* X. *The cumulative step-function of a random sample of N observations is expected to be fairly close to this specified distribution function. If it is not close enough, this is evidence that the hypothetical distribution is not the correct one. If* $F_0(X)$ *is the population cumulative distribution, and* $S_N(X)$ *the observed cumulative step-function of a sample (i.e.,* $S_N(X) = k/N$, *where* k *is the number of observations less than or equal to* X*), then the sampling distribution of* d *=maximum* $|F_0 - S_N(X)|$ *is known, and is independent of* $F_0(X)$ *if* $F_0(X)$ *is continuous.* (Massey 1951, p69)

Table 4-9 shows the K-S test statistics for the food safety issues based on SPSS 15.0. These results show that the hypothesis of no differences in the distribution of risk ratings from the two surveys for the use of antibiotics, and fat and cholesterol in food cannot be rejected at the 5% significance level. This result indicates that respondents' ratings of the risk for the use of antibiotics, and fat and cholesterol did not change significantly between 2003 and 2005. However the K-S tests for differences in the food risk rankings for bacteria contamination, pesticide residuals, use of hormones, mad cow disease, food additives, and the use of GM/GE are rejected at the 5% significance level. These results indicate that the distribution of these ratings from the 2003 and 2005 surveys are significantly different for the issues of bacteria contamination, pesticide residuals, use of hormones, mad cow disease, food additives, and the use of GM/GE in food production. Apparently, there was a change in the attitudes relative to perceptions of the risk associated with these issues

For the environmental safety issues, the K-S test results are shown in Table 4-10. The null hypothesis of the K-S test on the use of GM/GE cannot be rejected at the 5% significance level. That is, there was no significant change between 2003 and 2005 in the

distribution of respondents' attitudes risk rankings for the use of GM/GE on the environment. The test of no differences in rankings for water pollution, soil erosion, resistance to herbicides and pesticides, adverse effects on biodiversity, and agricultural waste disposal are rejected at the 5% significance level, indicating that the distributions of these concern ratings are significantly different between 2003 and 2005 for the issues of water pollution, soil erosion, resistance to herbicides and pesticides, adverse effects on biodiversity, and agricultural waste disposal.

Table 4-9 K-S Tests for Food Safety Issues

		Bacteria contamination	Pesticide residuals	Use of hormones	Use of antibiotics	Mad cow disease	Food additives	Use of GM/GE	Fat and cholesterol
Most extreme difference	Absolute value	0.224	0.119	0.076	0.043	0.221	0.095	0.186	0.056
	Positive value	0.032	0.046	0.076	0.043	0.221	0.095	0.186	0.056
	Negative value	-0.224	-0.119	0.000	-0.043	-0.032	-0.018	0.000	-0.009
K-S Z critical value		5.324	2.825	1.815	1.022	5.266	2.247	4.417	1.320
Calculated asymptomatic significance		0.000	0.000	0.003	0.247	0.000	0.000	0.000	0.061

Table 4-10 K-S Tests for Environmental Safety Issues

		Water pollution	Soil erosion	GM/GE	Resistance to herbicides &pesticides	Adverse effects on biodiversity	Agricultural waste disposal
Most extreme differences	Absolute value	0.138	0.075	0.053	0.261	0.213	0.192
	Positive value	0.000	0.000	0.053	0.000	0.213	0.000
	Negative value	-0.138	-0.075	-0.006	-0.261	0.000	-0.192
K-S Z critical value		3.270	1.791	1.265	6.217	5.067	4.568
Calculated asymptomatic significance		0.000	0.003	0.082	0.000	0.000	0.000

5 STATISTICAL MODELS TO EXPLAIN RISK RATINGS

5.1 Model Introduction

For the purpose of initial investigation, three types of models were initially applied to the data from the 2003 survey. Model 5.1 is based on the seemingly unrelated regression system (SUR). Following the procedure used by Roe et al. (2004), we applied an initial model for which we normalized respondents' levels of concern for food and environment safety by expressing these as deviations from the mean, across all concern rankings, for each individual respondent, as a procedure that focuses on the relative concern rankings of the various individuals. Then, SUR procedures were employed to estimate models based on the normalized data. The SUR approach involves a system of ordinary least square (OLS) regressions. The assumptions of the OLS procedure, such as the requirement for a normal distribution of residuals, are unlikely to be true for models with discrete dependant variables, necessitating the normalization procedure noted above.

In the analysis presented here, the SUR model is constructed as follows:

$$\hat{y}_{im} = x\,\beta_m + \varepsilon_{im} \tag{5.1}$$

where for the eight food safety issues m=1, 2...8; and for the six environmental safety issues m=1,2,...6; i = 1,2,...646 denotes individual respondents, and $\hat{y}_{im}$ is respondent i's normalized rating of the m th food safety or environmental safety, i.e.

$$\hat{y}_{im} = y_{im} - \bar{y}_i \tag{5.2}$$

Where m is the m th issue; x is a vector of socio-demographic and other characteristics of the respondent; β_m denotes the coefficients to be estimated and ε_{im} is an error term.

Model 5.3 is a multivariate probit system, this is the multivariate extension of the binomial probit model, available in Greene (2003, 2004), which builds on the suggestion of Manski and Lerman (1981) that multivariate normal probabilities be approximated by random sampling. The multivariate probit model extends the bivariate probit model to M equations, applying to each of the m issues, allowing information in the error terms of the

individual equations to be considered in the estimation process (Greene 2003). Thus in Model 2 below, m is the m-th food concern issue. For this model version, the original ordered responses indicating the food concern ratings (the dependent variables) were converted to binary choice data. Specifically, original responses of "1-high risk" and "2-moderate risk" were converted to "0-risk" while original responses "3- slight risk" and "4- almost no risk" were coded as "1-no risk". Consequently, the dependent variables contain only two categories: "risk" and "no risk". This procedure has the disadvantage of ignoring the intensity of concerns given in the original four-level responses. The procedure has the advantage of a system approach to estimation.

Following Greene (2003), the multivariate probit model is described as:

$$y(i,m)^* = \beta_m x + \varepsilon(i,m) \tag{5.3}$$

where m=8 for eight food safety issues; m=6 for six environmental issues; i=1, 2.....882, i denotes the i-th respondent; $y(i,m)=1$ *if* y(i,m)* > 0 ; $y(i,m)=0$, otherwise; x denotes the socio-demographic and other characteristics of the respondent and $\varepsilon(i,m)$, m=1, 2,...6 (or 8) are error terms, assumed to be normally distributed with variance 1 and correlation $r(m,l)$ (Greene 2003).

A third group of models, Ordered Probit models (5.4) are also employed to assess the underlying effects of socio-economic and demographic factors on each risk issue. This model takes particular cognizance of the ordered risk rankings of respondents, thus *a priori* these models have the advantage of fully using the ordered ranking data on risk perceptions. Following Greene (2003) these models are described as:

$$y_{mn}^* = x\beta + \varepsilon_{mn} \tag{5.4}$$

where m=8 for eight food safety issues; m=6 for six environment issues. n=1, 2.....882 in 2003 estimation, and n=1, 2.....1574 in 2005 estimation. n is the $n-th$ respondent.

Ordered Probit models assume that the rating measures that are available are based on the unobserved continuous dependent variable, y*. However, instead of y*, only the categorical value y, is observed. In our application of the individual Ordered Probit

model, the four category values represent the four concern rankings. Specifically, the four categories are given values 0, 1, 2 and 3:

$$y = 0 \text{ if } y^* < \mu_0 \text{ (where } \mu_0 \text{ equals zero)} \qquad (5.5)$$

$$y = 1 \text{ if } 0 <= y^* < \mu_1$$

$$y = 2 \text{ if } MU1 <= y^* < \mu_2$$

$$y = 3 \text{ if } MU2 <= y^* < \mu_3$$

where y is the observed choice of risk ranking categories given in the survey responses. Boundary values between the different categories are the parameters (μ) to be estimated. The μ parameters are labeled here based on the category value for which they are the lower bound. For example, μ_2 in is the lower bound for the category with value 2. We designate the lowest effective boundary value as zero. The thresholds can be explained as numerical linkages between the utility function of each respondent and hi/her ratings (Maddala, 1983). According to Greene, the estimated μ values follow the order $\mu_0 < \mu_1 < \mu_2 < \mu_3$. The distributions of the error terms ε are assumed to be normal (Greene 2003).

The various ordered probit model versions (Model 5.4) are estimated as separate regressions for each concern issue. The marginal effects show the probabilities of changes in the explanatory variables from one category value to the next. Marginal effects are computed from, and usually not equal to the estimated coefficients. Following Greene (2003) the four probabilities that apply in this analysis are:

$$\begin{aligned} \Pr(y = 0) &= \phi(-\beta' x) \\ \Pr(y = 1) &= \phi(\mu_1 - \beta' x) - \phi(-\beta' x) \\ \Pr(y = 2) &= \phi(\mu_2 - \beta' x) - \phi(\mu_1 - \beta' x) \\ \Pr(y = 3) &= 1 - \phi(\mu_2 - \beta' x) \end{aligned} \qquad (5.6)$$

For these probabilities, the marginal effects of the explanatory variables are:

$$\frac{\partial \Pr(y=0)}{\partial x} = -\phi(-\beta' x)\beta$$
$$\frac{\partial \Pr(y=1)}{\partial x} = [\phi(-\beta' x) - \phi(\mu_1 - \beta' x)]\beta \quad (5.7)$$
$$\frac{\partial \Pr(y=2)}{\partial x} = [\phi(\mu_1 - \beta' x) - \phi(\mu_2 - \beta' x)]\beta$$
$$\frac{\partial \Pr(y=3)}{\partial x} = [\phi(\mu_2 - \beta' x)]\beta$$

For estimation, the data needed to be assessed and adjusted as outlined in the following section.

5.2 Data Adjustments for Analysis

The objective of this study is to gain some understanding of Canadian consumers' food and environment risk perceptions. The dependent variables were the ratings the respondent gave for each of the food and environment risk issues: "high risk", "moderate risk", and "slight risk", almost no risk" or "don't know/not sure". For the estimation of Model 5.1 (SUR) and Model 5.3 (Multivariate Probit system), if a respondent provided a "don't know" answer to one of the questions, the observation is deleted. For Model 5.4 (ordered probit model), if a respondent answered "don't know" in one of the fourteen issues, the observation is omitted in estimation but only for that issue. For example, if a respondent answered, "don't know/not sure" to the risk rating question for "Bacteria contamination of food", then s/he was deleted in the estimation of the risk of "Bacteria contamination of food". However, if that respondent gave an answer other than "don't know/not sure" to the rating question "Pesticide residuals in food", then the observation would be analyzed in this issue.

For both the 2003 and 2005 data, "don't know" answers to gender, age, income, highest level of education and number of children in household were replaced with the median of all the other answers from the respondents. That is, in the 2003 data set , the 2 instances of no-responses for gender are replaced with female. Regarding age, 21 respondents gave no answer. The no-responses for ages are replaced with the median of 43 years. The instances of no-responses for the number of children in household are 12; the number of no-responses for education is 9; no-responses for employment amount to 31; no-responses for income are 164 and no-responses for how often respondents buy

organic food is 70. These are replaced by the median of the other responses in each case. The median of number of children in household is 0; the median education category is 6 (some university or college); median employment is category 1 (working full or part time); the median income is 6 ($50,000-$59,999) and the median of how often respondents buy organic food is 2 (Occasionally). Similarly, for the 2005 data, the "don't know" answers to social-economic questions were replaced with the median of the others' answers. This was the case for some 59 respondents who did not provide their age. The original 2005 data include 58 no-responses regarding the number of people in the household, 280 no-responses for the number of children, 18 no-responses for the highest education level, 62 no-responses for employment status, and 185 no-responses for income. These no-responses were replaced by the median values of the other respondents. The median age is 41; the median number of members in households is 2; the median number of children is 0; the median highest education level is category 6 (some university or college); the median employment status is category 1 (working full or part time); the median income is category 5 ($40,000-$49,999).

6 MODEL ESTIMATIONS AND RESULTS

6.1 Introduction

As described in Chapter 5, SUR (seemingly unrelated regression, Model 5.1), Mprobit (multivariate probit system, Model 5.3), and Oprobit (ordered probit, Model 5.4) models were used in initial estimations based on data obtained in 2003 and these results are reported in this chapter. Comparison of the three methods is made and the most appropriate method is applied in the estimation based on 2005 data. Only the results of ordered probit (Model 5.4) are discussed in this chapter.

Changes in attitudes to food safety may occur over time. For example, numbers of food safety events occurred and were noted in various media during the time between the two surveys [including two confirmed domestic cases of BSE (mad cow disease)]. These and other possible events raise the possibility that consumers' attitudes might change. To assess differences in the risk perceptions of consumers between the periods of the two surveys, we then also pooled the two reduced data sets and considered whether changes in the risk ratings or the explanators of these had occurred.

6.2 Estimated Results Assessing Influences on Risk Ratings Based on the 2003 Data

Variable definitions used for analysis of the 2003 data are given in Table 6-1. The estimation results and the marginal effects of significant variables of Model 5.4 (Oprobit) are shown in Tables 6-2 to 6-30. All of the ordered probit estimations are statistically significant, as seen from their chi-squared statistics as reported in Tables 6- 2 to 6-28.

For the issue of bacteria contamination (Table 6-2 and Table 6-3), Model 5.4 (Oprobit) has a larger restricted log-likelihood than Model 5.3 (Mprobit). The significant variables in Model 5.4 (Oprobit) are TRESEA (trustworthy or research institutes), AGE, CHILD and QC. The marginal effects of these significant variables on the four response categories (high risk, moderate risk, slight risk and almost no risk) are shown in Table 6-3. Marginal effects for dummy variables are calculated as Pr [y|x=1]-Pr[y|x=0]; marginal effects for continuous variables are calculated at the means of continuous variables. The marginal effect of TRESEA on "high risk" is -0.207, which means that if a respondent changes his/her assessment of trustworthiness from does not trust research institutes to does

trust research institutes, the probability of choosing Bacteria contamination as "high risk" would decrease by 20.7%. It appears those who trust research institutes more were less likely to view this issue as high risk. The estimated coefficient of age is significant, but the value is small. Being older increases the probability of choosing "bacterial contamination" as high risk. Respondents from Quebec had a higher probability of choosing bacteria contamination as high risk than those from the other provinces.

Table 6-1 Definitions of Independent Variables for Data Gathered in 2003

Independent Variables	Definitions
TGOV	Trustworthy: Canadian government. 1-trust, 0-not trust
TFOOD	Trustworthy: food industry. 1-trust, 0-not trust
TFARM	Trustworthy: farmers' assoc.1-trust, 0-not trust
TFAMIL	Trustworthy: family 1-trust, 0-not trust
TRESEA	Trustworthy: research inst. 1-trust, 0-not trust
TCONS	Trustworthy: consumer assoc. 1-trust, 0-not trust
AGE	Age in years
MALE	1-male; 0-female
CHILD	Number of children in household
UNIVER	1-university degree or graduate, 0-no university degree
EMPLOY	Employment status, 1-working full or part time, 0 -otherwise
INCOME	Total household income before taxes. 2-10,000-19,999; 3-20,000-29,999; 4-30,000-39,999; 5-40,000-49,999; 6- 50,000-59,999; 7- 60,000-69,999; 8-70,000-79,999; 9- 80,000-89,999; 10-90,000-99,999; 11-More than $100,000
BORG	1-often buy organic food; 0-occasionally or almost never buy organic food
BC	1-resident of British Columbia, 0-otherwise
PRAIRIE	1-resident of Alberta, Saskatchewan or Manitoba, 0-otherwise
ON	1-resident of Ontario, 0-otherwise
QC	1-resident of Quebec, 0-otherwise

Table 6-2 Bacteria contamination: Estimated Coefficients, 2003 data

	SUR Parameter Estimates	t-ratio	MProbit Parameter Estimates	t-ratio	OProbit Parameter Estimates	t-ratio
Constant	-0.303	-1.594	-0.163	-0.476	0.296	1.063
TGOV	-0.088	-1.518	0.194	1.931	0.105	1.26
TFOOD	-0.154**	-2.475	-0.159	-1.484	-0.131	-1.467
TFARM	-0.054	-0.877	0.039	0.372	0.075	0.832
TFAMIL	-0.015	-0.264	-0.123	-1.295	-0.092	-1.147
TRESEA	0.120	1.262	0.362**	2.021	0.526***	3.508
TCONS	0.228***	2.878	-0.024	-0.173	-0.004	-0.031
AGE	0.002	0.770	-0.003	-0.754	-0.007**	-2.292
MALE	-0.130**	-2.338	0.084	0.878	0.04	0.5
CHILD	0.032	1.270	0.110**	2.577	0.079**	2.15
UNIVER	-0.005	-0.089	0.036	0.354	0.114	1.355
EMPLOY	0.053	0.895	-0.086	-0.845	-0.044	-0.518
INCOME	-0.011	-0.966	-0.004	-0.210	0.005	0.306
BORG	0.203**	2.175	-0.227	-1.353	-0.213	-1.554
BC	-0.191	-1.486	-0.494**	-2.255	-0.329	-1.811
PRAIRIE	-0.137	-1.117	-0.314	-1.551	-0.255	-1.473
ON	-0.138	-1.286	-0.381**	-2.143	-0.294	-1.935
QC	-0.180	-1.615	-0.685***	-3.666	-0.612***	-3.845
R^2	0.106					
LL			-1423.00		-1062.06	
Restricted LL					-1094.44	
χ^2					64.76	
Degree of freedom					17	
N	882		879		853	
μ_1					0.645***	17.42
μ_2					1.512***	26.09

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Table 6-3 Bacteria Contamination: Estimated Marginal Effects for Model 5.4 (Oprobit), 2003 data

	High risk	Moderate risk	Slight risk	Almost no risk
TRESEA	-0.207	0.040	0.101	0.066
AGE	0.003	-0.0002	-0.001	-0.001
CHILD	-0.031	0.002	0.015	0.013
QC	0.24	-0.035	-0.117	-0.088

For the issue of pesticide residuals (Tables 6-4 and 6-5), the significant variables in Model 5.4 (Oprobit) are TGOV, BORG, MALE and QC. Respondents who trust government more were more likely to have a lower probability of choosing "high risk" and a higher probability of choosing "moderate risk", "slight risk" and "almost no risk". Those respondents who purchased organic food more often were more likely to view pesticide residuals as "high risk", indicating greater concerns by those respondents. Female respondents tended to choose pesticide residuals as more "high risk" than did males. Quebec consumers were more likely to view pesticide residuals to be "high risk".

Table 6-4 Herbicide/Pesticide Residuals : Three Models, Estimated Coefficients, 2003 data

	SUR Parameter Estimates	t-ratio	MProbit Parameter Estimates	t-ratio	OProbit Parameter Estimates	t-ratio
Constant	-0.098	-0.596	0.117	0.336	0.422	1.507
TGOV	0.038	0.764	0.270**	2.627	0.285***	3.378
TFOOD	0.019	0.358	0.055	0.503	0.098	1.096
TFARM	0.014	0.26	0.116	1.078	0.109	1.207
TFAMIL	0.029	0.607	-0.108	-1.101	-0.043	-0.54
TRESEA	-0.161	-1.96	0.082	0.458	0.181	1.229
TCONS	0.022	0.324	-0.305**	-2.226	-0.225	-1.948
AGE	0	-0.262	-0.005	-1.287	-0.006	-1.926
MALE	0.081	1.681	0.242**	2.471	0.239***	2.928
CHILD	-0.025	-1.13	0.033	0.751	0.069	1.877
UNIVER	0.04	0.8	0.201	1.947	0.162	1.908
EMPLOY	0.066	1.284	0.027	0.257	0.006	0.073
INCOME	-0.024**	-2.504	-0.029	-1.503	-0.006	-0.352
BORG	-0.141	-1.747	-0.850***	-4.213	-0.613***	-4.21
BC	0.029	0.26	-0.337	-1.405	-0.27	-1.464
PRAIRIE	-0.059	-0.556	-0.253	-1.143	-0.251	-1.44
ON	0.078	0.84	-0.188	-0.958	-0.173	-1.131
QC	-0.109	-1.136	-0.553***	-2.711	-0.579***	-3.615
R^2	0.031					
LL			-1423.00		-1017.64	
Restricted LL					-1070.22	
χ^2					105.16	
Degree of freedom					17	
N	882		879		848	
μ_1					0.707***	18.01
μ_2					1.669***	26.22

Note: ***significant at 0.01 level; **significant at 0.05 level.

Table 6-5 Pesticide Residuals: Estimated Marginal Effects of Model 5.4 (Oprobit), 2003 data

	High risk	Moderate risk	Slight risk	Almost no risk
TGOV	-0.1117	0.0136	0.0611	0.037
MALE	-0.0927	0.0084	0.051	0.0333
BORG	0.2406	-0.0585	-0.1249	-0.0572
QC	0.2273	-0.0398	-0.1214	-0.0661

In the estimation of risk ratings regarding use of hormones in food (Tables 6-6 and 6-7), the significant variables are TGOV, TFARM, TRESEA, TCONS, AGE, BORG and QC. Respondents who trusted government, farmer associations or research institutes more, were less likely to see the use of hormone in food as high risk. Those who trusted consumer associations more were more likely to view the use of hormones in food as a high risk. Older respondents had a higher probability of choosing "high risk". Those who report buying organic food tended to see the use of hormones in food as more risky; they may try to avoid risk by buying organic food.

Table 6-6 Use of Hormones in Food, Three Models, Estimated Coefficients, 2003 data

	SUR Parameter Estimates	t-ratio	MProbit Parameter Estimates	t-ratio	OProbit Parameter Estimates	t-ratio
Constant	-0.070	-0.400	0.192	0.584	0.371	1.305
TGOV	0.017	0.313	0.259***	2.597	0.200**	2.368
TFOOD	0.133**	2.333	0.106	0.992	0.175	1.951
TFARM	0.057	1.017	0.191	1.789	0.243***	2.682
TFAMIL	-0.062	-1.219	-0.164	-1.725	-0.122	-1.503
TRESEA	-0.011	-0.130	0.216	1.259	0.450***	2.987
TCONS	-0.036	-0.492	-0.326**	-2.410	-0.267**	-2.292
AGE	0.000	0.189	-0.007	-1.750	-0.008***	-2.592
MALE	0.034	0.668	0.256***	2.656	0.159	1.936
CHILD	0.001	0.046	0.065	1.480	0.066	1.780
UNIVER	-0.044	-0.814	0.111	1.083	0.098	1.144
EMPLOY	-0.021	-0.392	-0.163	-1.559	-0.108	-1.252
INCOME	-0.002	-0.169	-0.003	-0.146	0.026	1.593
BORG	-0.250***	-2.914	-0.710***	-3.882	-0.755***	-5.123
BC	-0.061	-0.522	-0.426	-1.839	-0.304	-1.611
PRAIRIE	0.061	0.540	-0.108	-0.497	-0.006	-0.036
ON	-0.026	-0.268	-0.330	-1.709	-0.187	-1.198
QC	0.039	0.387	-0.503**	-2.540	-0.330**	-2.029
R^2	0.030					
LL			-1423.00		-994.78	
Restricted LL					-1057.23	
χ^2					124.91	
Degree of freedom					17	
N	882		879		809	
μ_1					0.871***	20.51
μ_2					1.827***	29.06

Note: denotes ***significant at 0.01 level; **significant at 0.05 level; *significant at 0.1 level.

Table 6-7 Use of Hormones in Food: Estimated Marginal Effects for Model 5.4 (Oprobit), 2003 data

	High risk	Moderate risk	Slight risk	Almost no risk
TGOV	-0.0733	0.0014	0.0424	0.0295
TFARM	-0.089	0.0021	0.0514	0.0355
TRESEA	-0.1729	0.0259	0.0949	0.0521
TCONS	0.0924	0.0079	-0.0542	-0.046
AGE	0.003	0	-0.0018	-0.0013
BORG	0.2919	-0.0663	-0.1518	-0.0739
QC	0.1229	-0.0077	-0.07	-0.0451

TGOV, TFARM, TRESEA, MALE, CHILD, BORG and QC are significant in the estimation of food risk ratings for the use of antibiotics (Tables 6-8 and 6-9). Those who trusted the government, research institutes or farmer associations tended to have a lower probability of choosing "high risk". Men or those with more children appeared to perceive the use of antibiotics to be of less risk. Those buying organic food tended to have a higher probability of choosing "high risk" for antibiotic use. Respondents from Quebec were more likely to perceive the use of antibiotics as more risky.

Table 6-8 Use of Antibiotics, Three Models, Estimated Coefficients, 2003 data

	SUR Parameter Estimates	t-ratio	MProbit Parameter Estimates	t-ratio	OProbit Parameter Estimates	t-ratio
Constant	-0.449	-2.355	-0.175	-0.530	0.006	0.020
TGOV	0.049	0.841	0.331***	3.343	0.187**	2.172
TFOOD	0.100	1.608	0.085	0.824	0.143	1.565
TFARM	-0.028	-0.460	0.134	1.280	0.170	1.845
TFAMIL	0.037	0.669	-0.063	-0.659	-0.025	-0.303
TRESEA	0.060	0.633	0.202	1.160	0.378**	2.495
TCONS	0.009	0.116	-0.188	-1.363	-0.179	-1.517
AGE	0.004	1.955	-0.001	-0.376	-0.004	-1.354
MALE	0.085	1.516	0.322***	3.403	0.293***	3.528
CHILD	0.036	1.431	0.065	1.497	0.083**	2.204
UNIVER	-0.059	-1.012	0.131	1.302	0.093	1.069
EMPLOY	0.052	0.871	-0.022	-0.221	-0.049	-0.550
INCOME	0.002	0.150	-0.007	-0.368	0.030	1.818
BORG	-0.213**	-2.270	-0.691***	-3.920	-0.669***	-4.526
BC	0.024	0.184	-0.529**	-2.266	-0.202	-1.083
PRAIRIE	0.003	0.026	-0.239	-1.073	-0.048	-0.272
ON	-0.005	-0.043	-0.422**	-2.146	-0.246	-1.581
QC	-0.043	-0.388	-0.624***	-3.094	-0.511***	-3.148
R^2	0.023					
LL						
Restricted LL			-1550.28		-994.11	
χ^2					-1052.37	
Degree of freedom					116.51	
N	882		879		805	
μ_1					0.713***	17.95
μ_2					1.607***	26.71

Note: ***significant at 0.01 level; **significant at 0.05 level.

Table 6-9 Use of Antibiotics: Estimated Marginal Effects for Model 5.4 (Oprobit), 2003 data

	High risk	Moderate risk	Slight risk	Almost no risk
TGOV	-0.0717	0.0037	0.0369	0.0311
TFARM	-0.0649	0.0033	0.0334	0.0282
TRESEA	-0.1484	0.0206	0.0757	0.0521
MALE	-0.1104	0.0024	0.0565	0.0515
CHILD	-0.0317	0.0013	0.0164	0.0141
BORG	0.2618	-0.0528	-0.1301	-0.0788

TGOV, TFOOD, TFARM, AGE, UNIVER, ON and QC are significant in the estimation of ratings of food risks from "mad cow disease (BSE)" (Table 6-10 and Table 6-11), Trust in government, farmers associations seemed to decrease the probability of mad cow disease being viewed as "high risk", while having trust in the food industry appeared to increase the probability of mad cow disease being seen as "high risk". Older respondents were more likely to view mad cow disease as "high risk". Those who had received a university education were less likely to see mad cow disease as "high risk". Respondents living in Ontario or Quebec had a higher probability of choosing mad cow disease as "high risk".

Table 6- 10 Mad Cow Disease (BSE): Three Models, Estimated Coefficients, 2003 data

	SUR Parameter Estimates	t-ratio	MProbit Parameter Estimates	t-ratio	OProbit Parameter Estimates	t-ratio
Constant	0.550	2.404	0.913	2.670	0.893	3.067
TGOV	0.057	0.828	0.282***	2.883	0.268***	3.117
TFOOD	-0.337***	-4.509	-0.352***	-3.305	-0.355***	-3.789
TFARM	0.109	1.471	0.115	1.083	0.181**	1.966
TFAMIL	-0.069	-1.043	-0.172	-1.840	-0.138	-1.671
TRESEA	0.096	0.842	0.254	1.623	0.269	1.875
TCONS	0.016	0.169	-0.169	-1.226	-0.101	-0.848
AGE	-0.002	-0.672	-0.011***	-2.993	-0.009***	-2.885
MALE	-0.108	-1.607	0.102	1.074	0.043	0.510
CHILD	-0.025	-0.824	0.036	0.785	0.026	0.677
UNIVER	0.136	1.933	0.188	1.840	0.255***	2.925
EMPLOY	0.037	0.514	-0.002	-0.016	-0.082	-0.921
INCOME	0.002	0.164	-0.002	-0.121	0.028	1.674
BORG	0.278**	2.466	-0.032	-0.201	-0.071	-0.528
BC	-0.117	-0.756	-0.206	-0.843	-0.368	-1.862
PRAIRIE	-0.078	-0.530	-0.205	-0.867	-0.220	-1.158
ON	-0.217	-1.678	-0.356	-1.725	-0.419**	-2.486
QC	-0.469***	-3.502	-0.821***	-3.888	-0.813***	-4.647
R^2	0.071					
LL					-1030.84	
Restricted LL			-1550.28		-1084.43	
χ^2					104.98	
Degree of freedom					17	
N	882		879		838	
μ_1					0.323***	11.16
μ_2					0.832***	19.52

Note: ***significant at 0.01 level; **significant at 0.05 level; *significant at 0.1 level.

Table 6-11 BSE (mad cow disease): Marginal Effects for Model 5.4 (Oprobit), 2003 data

	High risk	Moderate risk	Slight risk	Almost no risk
TGOV	-0.0966	-0.0093	0.0068	0.0991
TFOOD	0.1283	0.0117	-0.0097	-0.1302
TFARM	-0.0649	-0.0065	0.0043	0.0671
AGE	0.0034	0.0004	-0.0002	-0.0035
UNIVER	-0.0892	-0.0105	0.0036	0.0961
ON	0.1515	0.0136	-0.0116	-0.1535
QC	0.3028	0.0128	-0.0399	-0.2757

In the ordered probit analysis for risk ratings of food additives (Table 6-12 and Table 6-13), TGOV, TCONS, AGE, MALE, EMPLOY and BORG are significant. Trusting government tended to decrease the probability of respondents' choosing "high risk" and "moderate risk", and increased the probabilities of choosing "slight risk" and "almost no risk". Those who trusted consumer associations were more likely to choose this issue as a "high risk". Being male appeared to decrease the probability of choosing "high risk" for food additives. Older respondents, those who were employed or those who bought organic food often were more likely to rate food additives as "high risk".

Table 6-12 Food Additives, Three Models, Estimated Coefficients, 2003 data

	SUR Parameter Estimates	t-ratio	MProbit Parameter Estimates	t-ratio	OProbit Parameter Estimates	t-ratio
Constant	0.272	1.424	0.892	2.759	1.497	5.575
TGOV	0.009	0.160	0.397***	4.027	0.320***	3.957
TFOOD	0.097	1.558	0.121	1.122	0.067	0.776
TFARM	-0.047	-0.764	0.108	1.001	0.101	1.167
TFAMIL	0.132**	2.386	-0.033	-0.346	0.024	0.317
TRESEA	-0.079	-0.830	-0.079	-0.484	0.133	0.985
TCONS	-0.101	-1.271	-0.542***	-3.671	-0.338***	-3.015
AGE	-0.004**	-2.006	-0.013***	-3.635	-0.012***	-3.982
MALE	0.083	1.479	0.356***	3.698	0.311***	3.946
CHILD	-0.046	-1.813	0.010	0.236	0.025	0.715
UNIVER	-0.107	-1.833	0.022	0.218	-0.026	-0.320
EMPLOY	-0.099	-1.678	-0.179	-1.755	-0.241***	-2.895
INCOME	0.018	1.671	0.024	1.281	0.026	1.706
BORG	-0.127	-1.355	-0.524***	-3.420	-0.609***	-4.591
BC	0.225	1.748	-0.118	-0.549	-0.008	-0.048
PRAIRIE	0.060	0.491	-0.218	-1.069	-0.131	-0.772
ON	0.131	1.218	-0.237	-1.315	-0.156	-1.047
QC	0.482***	4.324	-0.061	-0.330	0.079	0.511
R^2	0.073					
LL					-1061.36	
Restricted LL			-1550.28		-1118.19	
χ^2					113.64	
Degree of freedom					17	
N	882		879		850	
μ_1					1.066***	24.77
μ_2					2.171***	29.16

Note: ***significant at 0.01 level; **significant at 0.05 level.

Table 6-13 Food Additives: Estimated Marginal Effects for Model 5.4 (Oprobit), 2003 data

	High risk	Moderate risk	Slight risk	Almost no risk
TGOV	-0.0713	-0.0559	0.0567	0.0706
TCONS	0.0628	0.0695	-0.0451	-0.0872
AGE	0.0026	0.0023	-0.0021	-0.0028
MALE	-0.0647	-0.0584	0.0502	0.0729
EMPLOY	0.0502	0.0453	-0.0391	-0.0564
BORG	0.1666	0.0681	-0.1301	-0.1047

For the issue of food risk from GM/GE in food production (Table 6-14 and Table 6-15), TGOV, TFOOD, TRESEA, TCONS, MALE, UNIVER, EMPLOY, BORG and QC are significant. Trust in government or the food industry or research institutes seemed to decrease the respondents' probabilities of choosing "high risk", while having trust in consumer associations was more likely to increase the probability of choosing "high risk". Men and those with a university degree were less likely to perceive this issue to be "high risk". Those who were employed, bought organic food more often or lived in Quebec had lower probabilities of choosing "high risk".

Table 6-14 Use of GM/GM in Food Production, Three Models, Estimated Coefficients, 2003 data

	SUR Parameter Estimates	t-ratio	MProbit Parameter Estimates	t-ratio	OProbit Parameter Estimates	t-ratio
Constant	-0.089	-0.417	0.165	0.498	0.557	1.976
TGOV	0.085	1.323	0.416***	4.266	0.402***	4.765
TFOOD	0.160**	2.305	0.185	1.762	0.230**	2.566
TFARM	-0.021	-0.301	0.155	1.503	0.139	1.541
TFAMIL	-0.012	-0.195	-0.186**	-1.966	-0.129	-1.600
TRESEA	0.021	0.194	0.209	1.278	0.323**	2.235
TCONS	-0.286***	-3.230	-0.519***	-3.795	-0.529***	-4.444
AGE	0.008***	3.351	0.002	0.562	0.001	0.158
MALE	0.076	1.215	0.279***	2.904	0.354***	4.345
CHILD	-0.012	-0.414	0.065	1.470	0.060	1.620
UNIVER	0.169**	2.595	0.260**	2.578	0.259***	3.000
EMPLOY	-0.139**	-2.110	-0.21**1	-2.076	-0.228***	-2.620
INCOME	0.027**	2.209	0.025	1.303	0.031	1.923
BORG	-0.156	-1.498	-0.576***	-3.722	-0.719***	-5.055
BC	-0.034	-0.234	-0.480**	-2.154	-0.231	-1.235
PRAIRIE	0.205	1.502	-0.169	-0.759	0.046	0.253
ON	0.078	0.651	-0.310	-1.585	-0.134	-0.847
QC	-0.044	-0.356	-0.607***	-3.016	-0.440***	-2.693
R^2	0.072					
LL					-1025.45	
Restricted LL			-1074.15		-1114.54	
χ^2					178.16	
Degree of freedom					17	
N	882		879		808	
μ_1					0.771	19.11
μ_2					1.693	31.3

Note: ***significant at 0.01 level; **significant at 0.05 level.

Table 6-15 Use of GM in Food Production: Marginal Effects for Model 5.4 (Oprobit), 2003 data

	High risk	Moderate risk	Slight risk	Almost no risk
TGOV	-0.1151	-0.0442	0.0506	0.1087
TFOOD	-0.0626	-0.0287	0.0254	0.0658
TRESEA	-0.0992	-0.0291	0.0478	0.0805
TCONS	0.1215	0.0791	-0.0302	-0.1705
MALE	-0.0955	-0.0443	0.038	0.1018
UNIVER	-0.0694	-0.0329	0.0275	0.0748
EMPLOY	0.0616	0.0285	-0.0248	-0.0653
BORG	0.2416	0.0332	-0.1231	-0.1517
QC	0.1309	0.0433	-0.0605	-0.1138

Variables AGE and CHILD are significant in the ordered Probit estimation of risk assessments from fat and cholesterol in food (Table 6-16 and Table 6-17). Older respondents had a similar concern as with other issues: they were more likely than others to see fat and cholesterol as "high risk". Those with children in the household were less likely to view this issue as "high risk".

Table 6-16 Fat and Cholesterol, Three Models: Estimated Coefficients, 2003 data

	SUR Parameter Estimates	t-ratio	MProbit Parameter Estimates	t-ratio	OProbit Parameter Estimates	t-ratio
Constant	0.187	0.877	0.216	0.547	1.338	4.988
TGOV	-0.168***	-2.592	-0.033	-0.282	0.108	1.347
TFOOD	-0.018	-0.261	0.048	0.400	-0.006	-0.066
TFARM	-0.030	-0.434	0.043	0.355	0.097	1.138
TFAMIL	-0.040	-0.654	-0.265**	-2.332	-0.144	-1.866
TRESEA	-0.046	-0.430	0.136	0.620	0.216	1.592
TCONS	0.147	1.654	-0.097	-0.591	-0.050	-0.449
AGE	-0.008***	-3.211	-0.017***	-3.772	-0.016***	-5.278
MALE	-0.120	-1.919	0.189	1.624	0.082	1.051
CHILD	0.038	1.338	0.088*	1.687	0.105***	2.992
UNIVER	-0.130**	-1.988	0.059	0.486	-0.040	-0.486
EMPLOY	0.053	0.803	-0.125	-0.980	-0.043	-0.523
INCOME	-0.013	-1.075	-0.015	-0.688	-0.015	-0.993
BORG	0.406***	3.874	-0.137	-0.694	0.060	0.462
BC	0.125	0.868	0.200	0.761	-0.127	-0.711
PRAIRIE	-0.056	-0.405	-0.012	-0.048	-0.240	-1.406
ON	0.099	0.821	0.300	1.333	-0.117	-0.783
QC	0.324***	2.595	0.304	1.304	-0.058	-0.377
R^2	0.085					
LL			-1074.15		-1078.97	
Restricted LL					-1114.76	
χ^2					71.58	
Degree of freedom					17	
N	882		879		867	
μ_1					1.120	25.84
μ_2					2.055	34.31

Note: ***significant at 0.01 level; **significant at 0.05 level.

Table 6-17 Fat and Cholesterol: Marginal Effects, 2003 data

	High risk	Moderate risk	Slight risk	Almost no risk
AGE	0.0051	0.0008	-0.0034	-0.0026
CHILD	-0.033	-0.0054	0.0217	0.0166

Variables TGOV, BORG and QC are significant variables in the estimation of rankings for water pollution from agriculture as an environmental risk (Table 6-18 and Table 6-19). Those who trusted government more tended to have lower probabilities of choosing water pollution as "high risk"; respondents who bought organic food more often or lived in Quebec were more likely to consider water pollution as "high risk".

Table 6-18 Water Pollution from Agriculture, Three Models, Estimated Coefficients, 2003 data

	SUR Parameter Estimates	t-ratio	MProbit Parameter Estimates	t-ratio	OProbit Parameter Estimates	t-ratio
Constant	-0.308	-2.182	0.306	1.999	-0.332	-1.100
TGOV	-0.037	-0.855	0.258	1.892	0.268***	2.927
TFOOD	-0.087	-1.897	0.083	0.523	0.135	1.396
TFARM	0.043	0.944	0.075	0.566	0.134	1.358
TFAMIL	0.057	1.389	-0.126	-0.478	0.033	0.376
TRESEA	-0.118	-1.670	-0.157	-0.804	0.057	0.362
TCONS	0.076	1.288	-0.006	-1.049	-0.132	-1.078
AGE	-0.003**	-2.139	-0.088	-0.617	-0.006	-1.766
MALE	-0.068	-1.644	0.089	1.585	0.106	1.205
CHILD	-0.020	-1.058	0.070	0.473	0.033	0.842
UNIVER	0.041	0.948	0.140	0.912	0.138	1.508
EMPLOY	0.122***	2.773	-0.032	-1.110	0.148	1.581
INCOME	-0.008	-0.941	-0.442	-1.498	-0.024	-1.374
BORG	0.164**	2.367	-0.068	-0.221	-0.430***	-2.650
BC	0.010	0.102	0.213	0.744	0.176	0.900
PRAIRIE	0.024	0.264	0.066	0.258	0.172	0.914
ON	0.025	0.314	-0.285	-1.044	0.148	0.894
QC	-0.103	-1.252	0.306	-0.953	-0.354**	-2.009
R^2	0.050					
LL			-1274.75		-759.97	
Restricted LL					-798.71	
χ^2					77.68	
Degree of freedom					17	
N	882		879		865	
μ_1					1.056***	18.27
μ_2					1.880***	18.09

Note: ***significant at 0.01 level; **significant at 0.05 level; *significant at 0.1 level.

Table 6-19 Water Pollution from Agriculture: Marginal Effects of Model 5.4 (Oprobit), 2003 data

	High risk	Moderate risk	Slight risk	Almost no risk
TGOV	-0.0999	0.0608	0.0304	0.0087
BORG	0.1494	-0.0989	-0.0404	-0.0101
QC	0.1289	-0.0808	-0.0378	-0.0104

In the estimation of soil erosion from agriculture as a risk for the environment (Table 6-20 and Table 6-21), TGOV, MALE, CHILD, BORG and BC are significant. Those who trusted government more tended to rate less "high risk" in the issue of soil erosion. Men or those with children in the household had lower probabilities of rating this issue as "high risk". Respondents who bought organic food more often were more likely to view this issue as "high risk". Residents in British Columbia tended to have lower probabilities of rating this issue as "high risk".

Table 6-20 Soil Erosion: Three Models, Estimated Coefficients, 2003 data

	SUR Parameter Estimates	t-ratio	MProbit Parameter Estimates	t-ratio	OProbit Parameter Estimates	t-ratio
Constant	-0.064	-0.405	-0.531	-1.575	0.231	0.850
TGOV	-0.071	-1.490	0.185	1.829	0.183**	2.239
TFOOD	-0.048	-0.925	0.146	1.371	0.111	1.257
TFARM	-0.034	-0.665	-0.069	-0.652	-0.055	-0.633
TFAMIL	0.003	0.056	0.008	0.082	0.000	-0.001
TRESEA	0.004	0.055	0.023	0.136	0.201	1.458
TCONS	0.158**	2.402	-0.116	-0.868	-0.071	-0.636
AGE	-0.001	-0.327	-0.002	-0.503	-0.003	-0.849
MALE	-0.036	-0.777	0.199**	2.068	0.211***	2.672
CHILD	0.024	1.139	0.087**	2.012	0.078**	2.192
UNIVER	-0.002	-0.041	-0.010	-0.101	0.023	0.283
EMPLOY	0.012	0.254	0.016	0.156	-0.032	-0.385
INCOME	0.001	0.085	-0.022	-1.202	-0.015	-0.935
BORG	-0.039	-0.505	-0.529***	-2.857	-0.583***	-4.222
BC	0.254**	2.392	0.307	1.348	0.359**	1.973
PRAIRIE	0.014	0.139	0.212	0.953	0.125	0.713
ON	0.132	1.483	0.223	1.138	0.255	1.671
QC	0.285***	3.093	0.175	0.858	0.207	1.305
R^2	0.040					
LL					-1017.04	
Restricted LL			-1274.75		-1043.76	
χ^2					53.44	
Degree of freedom					17	
N	882		879		844	
μ_1					1.046***	23.484
μ_2					2.237***	30.679

Note: denotes ***significant at 0.01 level; **significant at 0.05 level.

Table 6-21 Soil Erosion: Marginal Effects of Model 5.4 (Oprobit), 2003 data

	High risk	Moderate risk	Slight risk	Almost no risk
TGOV	-0.0629	-0.0017	0.0469	0.0176
MALE	-0.071	-0.0047	0.0541	0.0216
CHILD	-0.0266	-0.0013	0.0201	0.0078
BORG	0.2177	-0.039	-0.1397	-0.0391
BC	-0.111	-0.0235	0.0897	0.0448

For the rankings of GM/GE in agriculture as a risk for the environment (Table 6-22 and Table 6-23), the significant variables are almost the same as for those given to GM/GE as a risk concern for food: TGOV, TFOOD, TCONS, MALE, UNIVER, EMPLOY and BORG are all significant. Those who trusted government or food industry had a lower probability of choosing GM/GE as "high risk" for the environment, while having trust in consumer associations increased the probability of choosing GM/GE as a "high risk" to the environment. Men and those with university education were less likely to see GM/GE as a high risk to the environment. Those who were employed or buy organic food more often were more likely to rate GM/GE as "high risk" for the environment.

Table 6-22 GM/GE as an Environmental Risk, Three Models, Estimated Coefficients, 2003 data

	SUR Parameter Estimates	t-ratio	MProbit Parameter Estimates	t-ratio	OProbit Parameter Estimates	t-ratio
Constant	-0.193	-0.929	-0.516	-1.565	0.077	0.237
TGOV	0.145**	2.298	0.416***	4.207	0.346***	3.518
TFOOD	0.121	1.792	0.280***	2.645	0.355***	3.485
TFARM	-0.069	-1.020	0.019	0.185	0.037	0.366
TFAMIL	-0.058	-0.956	-0.209**	-2.174	-0.166	-1.788
TRESEA	0.118	1.136	0.177	1.028	0.362	1.008
TCONS	-0.168	-1.941	-0.389***	-2.802	-0.302**	-2.184
AGE	0.008***	3.460	0.003	0.788	0.001	0.407
MALE	0.055	0.907	0.228**	2.441	0.373***	3.942
CHILD	0.005	0.195	0.057	1.314	0.075	1.809
UNIVER	0.167***	2.622	0.177	1.771	0.247**	2.455
EMPLOY	-0.131**	-2.024	-0.221**	-2.158	-0.264**	-2.568
INCOME	0.033***	2.779	0.022	1.197	0.015	0.842
BORG	-0.356***	-3.480	-0.879***	-4.685	-0.759***	-4.765
BC	-0.018	-0.130	0.062	0.267	-0.012	-0.057
PRAIRIE	0.039	0.291	0.145	0.673	-0.082	-0.408
ON	0.028	0.236	0.064	0.333	0.089	0.508
QC	-0.088	-0.721	-0.265	-1.316	-0.268	-1.482
R^2	0.088					
LL			-1274.75		-1015.97	
Restricted LL					-1099.83	
χ^2					167.73	
Degree of Freedom					17	
N	882		879		817	
μ_1					0.920***	21.628
μ_2					1.842***	31.440

Note: denotes ***significant at 0.01 level; **significant at 0.05 level.

Table 6-23 GM/GE as an Environmental Risk: Marginal Effects of Model 5.4 (Oprobit), 2003 data

	High risk	Moderate risk	Slight risk	Almost no risk
TGOV	-0.1164	-0.0145	0.0669	0.064
TFOOD	-0.1134	-0.0239	0.0648	0.0725
TCONS	0.0919	0.0267	-0.0519	-0.0667
MALE	-0.1207	-0.0225	0.0691	0.0741
UNIVER	-0.0795	-0.0158	0.0457	0.0496
EMPLOY	0.0846	0.0173	-0.0486	-0.0533
BORG	0.2817	-0.0291	-0.1519	-0.1007

In terms of the environmental risks from resistance to herbicides and pesticides (Table 6-24 and Table 6-25), the significant variables explaining risk ratings are: TGOV, TFOOD, TRESEA, TCONS, MALE, UNIVER, EMPLOY and BORG. Those with more trust in government or the food industry or research institutes had lower probabilities of choosing "high risk", whereas those with trust in consumer associations were more probable to choose "high risk". Respondents with higher education tended to see the risk of resistance to herbicides and pesticides as less risky. Men were less likely to view this issue as "high risk". Those who bought organic food more often were more likely to see this issue as "high risk".

Table 6-24 Resistance to Herbicides & Pesticides: Three Models, Estimated Coefficients, 2003 data

	SUR Parameter Estimates	t-ratio	MProbit Parameter Estimates	t-ratio	OProbit Parameter Estimates	t-ratio
Constant	-0.240	-1.542	-1.183	-2.777	-0.012	-0.044
TGOV	0.067	1.426	0.374***	2.888	0.401***	4.757
TFOOD	0.026	0.512	0.240	1.888	0.377***	4.214
TFARM	0.001	0.012	0.187	1.318	0.031	0.350
TFAMIL	0.016	0.350	-0.046	-0.401	-0.105	-1.305
TRESEA	0.080	1.030	0.202	0.873	0.303**	2.111
TCONS	-0.062	-0.949	-0.414***	-2.736	-0.395***	-3.435
AGE	0.002	0.919	0.004	0.865	0.003	0.856
MALE	-0.021	-0.464	0.195	1.728	0.375***	4.621
CHILD	0.000	0.011	0.054	1.033	0.063	1.700
UNIVER	-0.016	-0.339	0.028	0.235	0.182**	2.134
EMPLOY	0.034	0.710	0.090	0.741	-0.218**	-2.523
INCOME	-0.013	-1.393	-0.040	-1.733	0.020	1.247
BORG	0.062	0.815	-0.563**	-2.153	-0.779***	-5.489
BC	-0.164	-1.559	-0.250	-0.951	0.133	0.722
PRAIRIE	-0.092	-0.913	0.183	0.776	0.126	0.712
ON	-0.100	-1.137	-0.027	-0.127	0.124	0.801
QC	-0.244	-2.681	-0.384	-1.645	-0.214	-1.329
R^2	0.022					
LL			-1294.66		-850.33	
Restricted LL					-896.79	
χ^2					92.93	
Degree of freedom					17	
N	882		879		852	
μ_1					1.045***	20.089
μ_2					2.176***	20.676

Note: Denotes ***significant at 0.01 level; **significant at 0.05 level.

Table 6-25 Resistance to Herbicides & Pesticides: Marginal Effects of Model 5.4 (Oprobit), 2003 data

	High risk	Moderate risk	Slight risk	Almost no risk
TGOV	-0.1349	-0.0149	0.0779	0.072
TFOOD	-0.1209	-0.0233	0.0699	0.0743
TRESEA	-0.1066	-0.0032	0.0611	0.0487
TCONS	0.1178	0.0369	-0.0668	-0.0879
MALE	-0.1211	-0.0223	0.07	0.0734
UNIVER	-0.0592	-0.0107	0.0345	0.0354
EMPLOY	0.0709	0.0128	-0.0413	-0.0424
BORG	0.2904	-0.0379	-0.1547	-0.0979

For adverse effects of agriculture on biodiversity (Table 6-26 and Table 6-27), the significant variables are TGOV, TFOOD, MALE, BORG and QC. Those who trusted government more, or trusted the food industry more, were male, were less likely to rate this issue as "high risk". Respondents who bought organic food more often or trusted consumers' associations more or lived in Quebec were more likely to view this issue as "high risk".

Table 6-26 Adverse Effects of Agriculture on Biodiversity, Three Models, Estimated Coefficients, 2003 data

	SUR Parameter Estimates	t-ratio	MProbit Parameter Estimates	t-ratio	OProbit Parameter Estimates	t-ratio
Constant	0.259	1.349	-0.311	-0.951	-0.074	-0.254
TGOV	-0.086	-1.480	0.162	1.638	0.300***	3.409
TFOOD	0.090	1.437	0.162	1.558	0.240**	2.577
TFARM	-0.007	-0.116	0.041	0.391	0.046	0.491
TFAMIL	-0.168***	-3.018	-0.153	-1.610	-0.130	-1.548
TRESEA	-0.075	-0.785	-0.025	-0.153	0.235	1.554
TCONS	-0.074	-0.928	-0.224	-1.669	-0.229	-1.926
AGE	0.007***	3.144	0.003	0.682	-0.004	-1.096
MALE	-0.023	-0.410	0.234**	2.468	0.187**	2.228
CHILD	0.033	1.290	0.107**	2.425	0.070	1.860
UNIVER	-0.073	-1.241	-0.040	-0.412	0.028	0.320
EMPLOY	-0.028	-0.471	-0.024	-0.236	0.000	-0.003
INCOME	0.007	0.589	-0.022	-1.194	-0.019	-1.127
BORG	-0.040	-0.423	-0.362**	-2.165	-0.490***	-3.200
BC	-0.026	-0.203	-0.099	-0.452	0.115	0.602
PRAIRIE	0.115	0.933	0.270	1.332	0.112	0.608
ON	-0.052	-0.482	0.011	0.062	0.102	0.634
QC	0.070	0.627	-0.076	-0.409	-0.402**	-2.360
R^2	0.038					
LL			-1294.66		-938.86	
Restricted LL					-972.49	
χ^2					67.27	
Degree of freedom					17	
N	882		879		782	
μ_1					1.123***	23.784
μ_2					2.193***	30.304

Note: ***significant at 0.01 level; **significant at 0.05 level

Table 6-27 Adverse Effect of Agriculture on Biodiversity: Marginal Effects of Model 5.4 (Oprobit), 2003 data

	High risk	Moderate risk	Slight risk	Almost no risk
TGOV	-0.1187	0.0551	0.0541	0.0095
TFOOD	-0.0956	0.0415	0.0456	0.0086
MALE	-0.0745	0.0328	0.0352	0.0065
BORG	0.1878	-0.1026	-0.0743	-0.0108
QC	0.1579	-0.0779	-0.0686	-0.0114

In the estimation of the rankings given to environmental risks of agricultural waste disposal (Table 6-28 and Table 6-29), TGOV, AGE, MALE and BORG are significant. Those who trusted the government more tended to view agriculture waste disposal less risky. Being older or female or buying organic food more often had higher probabilities of rating this issue as "high risk".

Table 6-28 Agriculture Waste Disposal: Three Models, Estimated Coefficients, 2003 data

	SUR Parameter Estimates	t-ratio	MProbit Parameter Estimates	t-ratio	OProbit Parameter Estimates	t-ratio
Constant	0.546	3.339	0.190	0.545	0.721	2.646
TGOV	-0.018	-0.366	0.217**	1.962	0.201**	2.414
TFOOD	-0.103	-1.928	0.142	1.241	0.057	0.643
TFARM	0.066	1.247	0.095	0.806	0.125	1.404
TFAMIL	0.150***	3.178	0.166	1.644	0.143	1.807
TRESEA	-0.009	-0.113	-0.103	-0.568	0.135	0.958
TCONS	0.071	1.038	-0.157	-1.120	-0.117	-1.045
AGE	-0.013***	-6.811	-0.017***	-4.173	0.017***	-5.343
MALE	0.093	1.940	0.302***	2.954	0.297***	3.708
CHILD	-0.042	-1.959	0.029	0.639	0.009	0.253
UNIVER	-0.117**	-2.332	-0.160	-1.498	-0.109	-1.296
EMPLOY	-0.010	-0.187	-0.078	-0.718	0.077	-0.905
INCOME	-0.020**	-2.169	-0.042**	-2.066	0.020	-1.283
BORG	0.208***	2.589	-0.102	-0.595	-0.320**	-2.259
BC	-0.055	-0.504	-0.054	-0.218	0.049	0.264
PRAIRIE	-0.101	-0.959	0.030	0.131	0.094	0.536
ON	-0.032	-0.350	0.096	0.469	0.070	0.456
QC	0.080	0.837	0.031	0.150	0.061	0.382
R^2	0.105					
LL			-1294.66		-1033.74	
Restricted LL					-1077.56	
χ^2					87.64	
Degree of freedom					17	
N	882		879		866	
μ_1					0.917***	21.449
μ_2					1.690***	27.336

Note: ***significant at 0.01 level; **significant at 0.05 level

Table 6-29 Agriculture Waste Disposals: Marginal Effects of Model 5.4 (Oprobit), 2003 data

	High risk	Moderate risk	Slight risk	Almost no risk
TGOV	-0.0783	0.0161	0.0355	0.0267
TFAMIL	-0.0556	0.0105	0.0254	0.0197
AGE	0.0066	-0.0013	-0.003	-0.0023
MALE	-0.1142	0.0195	0.0524	0.0423
BORG	0.1264	-0.0354	-0.0549	-0.0361

6.3 Comparison of the Three Models Tested

From the estimation results, Mprobit and Oprobit were found to have consistent results. The significance of coefficients of the SUR model seems to vary from the estimates based on the Mprobit and Oprobit methods. There are two possible explanations: the process of data normalization undertaken for the SUR models may be identifying influences that only appear or become evident after adjusting the data for variations between individuals (because of the normalization process). Alternatively it may be that the data normalization process is insufficient to overcome the underlying discrete nature of the data. If the latter is the case, the use of the SUR model is inappropriate, since few of the assumptions of OLS (ordinary least squares) will be satisfied. Because of the concern that the latter situation applies, and because the characteristics of the ordered probit model are particularly relevant to the characteristics of the underlying data set, we concluded that the most appropriate model for subsequent analyses is the ordered Probit model.

6.4 Summary of Oprobit Results of Risk Ratings Based on the 2003 Data

Considering the attitudinal variables assessed as explainators of risk ratings, TRESA (trustworthiness of information from research institutes, 1- trust, 0- no trust, mean 0.916), TCONS (trustworthiness of information from consumer associations, 1- trust, 0- no trust, mean 0.872), TGOV (trustworthiness of information from government, 1- trust, 0- no trust, mean 0.622) are the most trustworthy information sources rated by respondents to the 2003 survey. TGOV (having trust in government) seems to have an influence on numbers of issues: those who trusted government more tended to have lower probabilities of choosing "high risk" for pesticide residuals, use of hormones, use of antibiotics, BSE (mad cow disease), use of food additives, use of GM/GE, water

pollution, soil erosion, GM/GE, resistance to herbicides and pesticides, adverse effects on biodiversity and agricultural waste disposal.

TFOOD (having trust in the food industry) is significant in the estimation of risk ratings BSE (mad cow disease), use of GM/GE as a food risk, and the effect of GM/GE on the environment, effects of herbicide and pesticide use on the environment, and adverse effects of agriculture on biodiversity. In terms of environmental riskiness, TFOOD affected risk ratings for the use of GM/GE, herbicide and pesticide use and adverse effects of agriculture on biodiversity. However, those who trusted the food industry were more likely to perceive mad cow disease as a "high risk".

TFARM (trust in farmers' association) is significant in the estimation of the ratings for the riskiness to food of hormones in food production, use of antibiotics. Those with trust in farmers' associations were more likely to have a lower probability of choosing "high risk" for all of these three issues.

Having more trust in family and friends tended to decrease the probability of choosing "high risk" in the estimation of risk ratings for agricultural waste disposal.

TRESEA (trust in research institutes) is significant in the estimation of riskiness ratings for bacteria contamination, use of GM in food production, use of antibiotics, use of hormones in food and resistance to herbicides and pesticides. Trusting research institutes more decreased the probability of choosing "high risk" and increases the probability of choosing "almost no risk".

TCONS (having trust in consumers associations) is significant and increases probabilities of choosing "high risk" for use of hormones, food additives, GM/GE as a food risk GM/GE as an environmental risk and resistance to herbicides and pesticides.

Older respondents were significantly more likely to rate "high risk" for bacteria contamination, use of hormones in food, mad cow disease (BSE), food additives, fat and cholesterol in food and agricultural waste disposal than were younger respondents. This indicates that the older the respondents are, the more risk they saw in certain food and environment issues.

Being male significantly decreased the probability of expressing "high risk" for food safety relative to the pesticide residuals, use of antibiotics, food additives, and use of GM/GE in food production. This was also the case for the risk ratings given soil erosion,

GM/GE as an environmental risk, resistance to herbicides and pesticides, adverse effects of agriculture on biodiversity and agricultural waste disposal. Males are less likely to view risks in these food and environment issues than females. The presence of children in a household significantly increased the probabilities of choosing "high risk" for bacteria contamination, use of antibiotics, fat and cholesterol and soil erosion. For those who had received a university education, the probabilities of choosing "high risk" were decreased significantly for BSE (mad cow disease), use of GM/GE in food production and GM/GE as an environmental risk and resistance to herbicides and pesticides. For those who were employed, the probabilities of choice of the rating "high risk" were increased significantly for food additives, use of GM/GE in food production and GM/GE as an environmental risk and resistance to herbicides and pesticides.

For respondents living in Quebec, the probabilities of "high risk" ratings were higher than for other Canadians for the risk issues of bacteria contamination, pesticide residuals, use of hormones, BSE (mad cow disease), use of GM/GE in food production, water pollution from agriculture and resistance to herbicides and pesticides.

6.5 Estimated Oprobit Results Assessing Influences on Risk Ratings Based on the 2005 Data

As outlined in Chapter 4, the 2005 survey included questions asking respondents' to assess questions similar to those used in the 2003 survey. Independent variables for analysis of the 2005 survey data set include demographic variables and some but not all the attitudinal variables available from the 2003 survey. Independent variable definitions for the tests on the 2005 data are presented in Table 6-30.

Table 6-30 Independent Variable Definitions, 2005 data

Variable	Measurement
MALE	1-male; 0-female
AGE	Age in years
CHILD	Number of children in household
UNIVER	1-university degree or graduate, 0-less than university degree
EMPLOY	Employment status, 1-working full or part time, 0 -otherwise
INCOME	Household income before tax 2-10,000-19,999; 3-20,000-29,999; 4-30,000-39,999; 5-40,000-49,999; 6- 50,000-59,999; 7- 60,000-69,999; 8- 70,000-79,999; 9- 80,000-89,999; 10-90,000-99,999; 11-More than $100,000
BC	1-resident of British Columbia; 0-otherwise
PRAIRIE	1-resident of Alberta, Saskatchewan or Manitoba; 0-otherwise
ON	1-resident of Ontario; 0-otherwise
QC	1-resident of Quebec; 0-otherwise
ATLAN	1-resident of Atlantic Provinces(New Brunswick, Newfoundland, Nova Scotia, Prince Edward Island) ; 0-otherwise
TFRIEND	Trustworthy: friend and family. 1-trust, 0-not trust
TNEWS	Trustworthy: newspaper and magazines. 1-trust, 0-not trust
TRADIO	Trustworthy: radio and TV. 1-trust, 0-not trust
TINTER	Trustworthy: the internet. 1-trust, 0-not trust
TDOCTOR	Trustworthy: doctor. 1-trust, 0-not trust
TUNIVER	Trustworthy: university. 1-trust, 0-not trust

From earlier comparison of the three methods originally considered (SUR, Mprobit and Oprobit), the use of Oprobit (Ordered Probit) models was concluded to be more appropriate for 2003 data, so this method was applied to the 2005 survey data. As shown earlier in Table 4-5, the issue of bacteria contamination was ranked as the second highest risk food (in terms of the percentage of respondents citing this as "high risk") in the eight food safety issues in 2003, but as the last highest food risk in 2005 (Table 4-7). Ordered Probit estimation results of the 2005 data of the initial three issues of bacteria contamination, pesticide residuals and use of hormones are presented in Table 6-31 and Table 6-32. Comparison with the Ordered Probit estimations in 2003 (Table 6-2) and 2005 (Table 6-31) indicate that the importance of MALE increased significantly (that is, MALE is not significant in 2003, but is significant in 2005). The marginal effects for MALE show that being male would decrease the probability of choosing bacteria contamination as a "high risk" by 6.9%, decrease the probability of choosing "moderate risk" by 3.3%, increase the probability of choosing "slight risk" by 6.4% and increase the

probability of choosing "almost no risk" by 3.8%. Marginal effects of INCOME show those with higher incomes were less likely than others to rate bacteria contamination as "high risk" in 2005. Having an increment of $10,000 of higher income would decrease the probability of choosing bacteria contamination as "high risk" by 0.7%, and increase the probability of choosing "almost no risk" by 4%.

Pesticide residuals were rated by 29% of respondents to be "high risk" in 2005, but this rating was given by more respondents (41%) in 2003 than in 2005 (Table 4-5). As shown in Table 6-31, AGE, UNIVER and INCOME are statistically significant in 2005. From Table 6-32, being male tended to decrease the probability of rating pesticide residuals as "high risk" by 13.7%. The model also predicts that respondent who are older would be more likely to rate pesticides residuals as "high risk". Having a university degree tended to increase the probability of rating pesticide residuals as "high risk" by 6.2%. Overall then, while AGE, UNIVER and INCOME were not significant in 2003 for the estimation of pesticide residuals, the models estimated on 2005 data indicated that those with higher incomes tended to choose pesticides as a less risky issue than did other groups in 2005 (although these variables were not significant in 2003), while older respondents, those with university degrees and people living in Quebec appeared to rate pesticides as a more risky issue in 2005 than in 2003. The significant 2005 results for income are consistent with some other literature. For example, Roe et al. (2004) found that U.S. respondents with lower incomes tended to give higher food safety concern ratings than other respondents. Similarly, U.S. consumers with annual incomes less than US$40,000 were more likely to express concern about pesticides than were those with higher incomes (Govindasamy and Italia, 1998). It may be that people with higher incomes view themselves as being able to offset food risks by buying higher quality or organic food.

In 2005 the use of hormones was ranked as the highest risk of all the eight food safety issues; the percentage of those rating this issue as "high risk" did not change much in the two years (high risk ratings were given by 33.4% of respondents in 2005 and by 31.6% in 2003). From Table 6-32 it is seen that males were less likely than females to view the use of hormones as risky in 2005 and that those with higher income tended to rate the use of hormones as less risky than respondents with lower income. The results in

Table 6-32 indicate that being male decreased the likelihood of a respondent rating the use of hormones as a high risk by 11.2%, while being a respondent with a higher income tended to decrease the probability of choice of a high risk rating for hormone risk by 1%.

Table 6-31 Bacteria contamination, Pesticide Residuals and Use of Hormones: Estimated Coefficients for Model 5.4 (Oprobit), 2005 data

	Bacteria contamination		Pesticide residuals		Use of hormones	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
ONE	0.945***	5.869	0.565***	3.503	0.442***	2.673
MALE	0.259***	4.548	0.402***	6.974	0.306***	5.229
AGE	-0.005**	-2.364	-0.006***	-3.119	-0.004	-1.867
CHILD	-0.039	-1.651	-0.030	-1.246	-0.040	-1.614
UNIVER	-0.007	-0.105	-0.178***	-2.650	-0.132	-1.939
EMPLOY	-0.047	-0.785	-0.093	-1.528	-0.120	-1.943
INCOME	0.028**	2.474	0.042***	3.774	0.028**	2.423
BC	-0.008	-0.063	0.040	0.306	-0.067	-0.494
PRAIRIE	0.145	1.181	0.050	0.403	0.139	1.088
ON	-0.156	-1.377	-0.092	-0.803	-0.016	-0.134
QC	-0.123	-1.037	-0.251**	-2.102	-0.204	-1.657
TFRIEND	-0.028	-0.259	-0.084	-0.766	-0.036	-0.321
TNEWS	0.059	0.831	0.066	0.917	0.071	0.966
TRADIO	-0.036	-0.425	-0.022	-0.253	0.047	0.540
TINTER	-0.012	-0.208	0.083	1.480	-0.002	-0.038
TDOCTOR	-0.074	-1.004	-0.009	-0.119	-0.043	-0.572
TUNIVER	0.016	0.278	-0.060	-1.029	-0.053	-0.894
TGOV	0.075	1.088	0.141**	2.024	0.075	1.068
LL	-1905.32		-1882.18		-1850.16	
restricted LL	-1930.560		-1930.750		-1880.780	
χ^2	50.480		97.130		61.000	
Degrees of freedom	17		17		17	
N	1538		1545		1502	
μ_1	1.048***	32.548	0.994***	30.849	0.961***	29.896
μ_2	2.319***	48.696	2.184***	41.245	1.926***	38.507

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Table 6-32 Bacterial in Food, Pesticide Residuals and Use of Hormones, Marginal Effects of Model 5.4 (Oprobit), 2005 data

Issues	Variables	High risk	Moderate risk	Slight risk	Almost no risk
Bacteria Contamination	MALE	-0.069	-0.033	0.064	0.038
	AGE	0.001	0.001	-0.001	-0.001
	INCOME	-0.007	-0.004	0.007	0.004
		High risk	Moderate risk	Slight risk	Almost no risk
Pesticide Residuals	MALE	-0.137	-0.009	0.102	0.043
	AGE	0.002	0	-0.002	-0.001
	UNIVER	0.062	0.001	-0.046	-0.017
	INCOME	-0.015	-0.001	0.011	0.005
	QC	0.089	-0.001	-0.064	-0.024
	TGOV	-0.047	-0.005	0.036	0.016
		High risk	Moderate risk	Slight risk	Almost no risk
Use of Hormones	MALE	-0.112	0.008	0.066	0.038
	INCOME	-0.01	0.001	0.006	0.003

Table 6-33 and Table 6-34 show the estimation result of the risk rankings for the use of antibiotics, use of GM/GE, and mad cow disease (BSE). In interpreting these it is of interest that overall, 31% of respondents rated the use of antibiotics as "high risk" in 2005, while 34% gave this rating in 2003 as seen in Table 4-5. From Tables Table 6-33 and Table 6-34, men and those with higher incomes (expressed in a $10,000 increment) were less inclined than others to consider the use of antibiotics as "high risk" for food safety in 2005 (these were not significant variables in 2003). The likelihood for male respondents of choosing the use of antibiotics to be "high risk" was decreased by 9.7%; respondents with higher incomes were 9% less likely to choose the use of antibiotics as "high risk".

Over all, 28.6% of respondents rated the use of GM/GE to increase food production as a "high risk" food issue in 2005 (Table 4-6) while only 20.7% of respondents saw GM/GE in agriculture as "high risk" for food in 2003 (Table 4-5). From both Table 6-33 and Table 6-34, men were less inclined to view the use of GM/GE in food production as a high food risk issue. Men were 9.5% less likely to rate the use of GM/GE as "high risk". In 2005, GM/GE was still viewed as more risky by Quebec

residents than those who resided in other provinces. The marginal effect of QC (being resident in Quebec) indicated that this increased the likelihood of choice of a "high risk" rating for the use of GM/GE by 10.7%.

Relative to the responses regarding BSE (mad cow disease), in the time period between the two surveys, it is of interest that three cases of BSE were found in Canada during this period—one in 2003 (confirmed as positive on May 20, 2003 by the CFIA and two in 2005 (confirmed as positive on January 2 and 11 2005). In addition a cow in Washington State, confirmed to have BSE on December 25, 2003 was found to have been born on a Canadian (Alberta) farm (CFIA, 2006). Thus it might be expected that Canadian's rankings of concern might have increased for BSE as a food safety issue. However, the percentage of Canadians rating mad cow disease as a major food risk (i.e. as a "high risk") issue actually declined from 31.7% to 24.1% over this time period according to the results given earlier in Tables 4-5 and 4-6. Data in Table 6-33 shows that respondents with children were more likely than others to consider mad cow disease to be risky in 2005 (although this variable was not significant in 2003). Men and those with higher incomes were 6.9% less likely than others to perceive mad cow disease as a "high risk" issue in 2005. Quebec residents were 13.3% more likely to choose BSE as " high risk" than residents in other provinces in 2005. Our finding that Canadians' concern with mad cow disease as a high risk issue may have eased between 2003 and 2005 does not support an initial hypothesis that people may tend to view BSE as more risky as more instances of this animal disease are found. The relatively low number of incidents in which BSE was found and the potential perception that the risk issue is under control may underlie this tendency and tends to suggest successful risk communication has occurred relative to these incidents. Further research relative to this issue is recommended.

Table 6-33 Use of Antibiotics, Use of GM/GE, Mad Cow Disease (BSE): Estimated Coefficients for Model 5.4 (Oprobit), 2005 data

	Use of Antibiotics		Use of GM/GE		Mad Cow Disease (BSE)	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
ONE	0.628	3.728	0.462	2.813	0.691	4.291
MALE	0.269***	4.566	0.277***	4.785	0.225***	3.940
AGE	-0.007***	-3.122	-0.003	-1.555	-0.005**	-2.180
CHILD	-0.032	-1.314	-0.052**	-2.123	-0.064***	-2.689
UNIVER	-0.139**	-2.035	0.024	0.356	-0.081	-1.226
EMPLOY	-0.057	-0.919	-0.085	-1.381	0.027	0.443
INCOME	0.025**	2.176	0.024**	2.130	0.046***	4.083
BC	-0.053	-0.384	0.042	0.313	0.035	0.267
PRAIRIE	0.082	0.636	0.115	0.906	0.192	1.555
ON	-0.085	-0.709	0.093	0.794	-0.190	-1.664
QC	-0.291**	-2.323	-0.301**	-2.468	-0.403***	-3.380
TFRIEND	-0.130	-1.157	-0.107	-0.962	0.061	0.562
TNEWS	0.085	1.156	0.077	1.060	0.128	1.798
TRADIO	0.058	0.667	-0.074	-0.844	-0.125	-1.461
TINTER	0.088	1.526	0.055	0.979	-0.060	-1.068
TDOCTOR	0.071	0.940	-0.132	-1.745	-0.037	-0.504
TUNIVER	-0.128	-1.144	0.059	1.002	0.083	1.419
TGOV	0.065	0.916	0.079	1.127	0.094	1.366
LL	-1864.734		-1895.157		-2060.95	
Restricted LL	-1897.880		-2025.680		-2115.181	
χ^2	66.290		81.050		108.4629	
Degrees of freedom	17		17		17	
N	1475		1504		1539	
μ_1	0.897***	28.786	0.780***	27.207	0.765***	27.317
μ_2	1.848***	39.211	1.673***	40.682	1.631***	42.800

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Table 6-34 Use of Antibiotics, Use of GM/GE and Mad Cow Disease (BSE), Marginal Effects of Model 5.4 (Oprobit), 2005 data

Issues	Variables	High risk	Moderate risk	Slight risk	Almost no risk
Use of Antibiotics	MALE	-0.097	0	0.057	0.04
	AGE	0.002	0	-0.001	-0.001
	UNIVER	0.051	-0.002	-0.029	-0.02
	INCOME	-0.009	0	0.005	0.004
	QC	0.108	-0.007	-0.062	-0.039
Use of GM/GE		High risk	Moderate risk	Slight risk	Almost no risk
	MALE	-0.095	-0.012	0.049	0.059
	CHILD	0.018	0.002	-0.009	-0.011
	INCOME	-0.008	-0.001	0.004	0.005
	QC	0.107	0.007	-0.056	-0.058
		High risk	Moderate risk	Slight risk	Almost no risk
(BSE) Mad Cow Disease	MALE	-0.069	-0.02	0.03	0.059
	AGE	0.001	0	-0.001	-0.001
	CHILD	0.020	0.006	-0.009	-0.017
	INCOME	-0.014	-0.004	0.006	0.012
	QC	0.133	0.026	-0.062	-0.096

Table 6-35 and Table 6-36 show the Ordered Probit estimation results of risk ratings for food additives and fat & cholesterol using 2005 data. The percentage of those respondents who chose "high risk" for use of food additives was 25.1% in 2005 as shown in earlier Table 4-5, almost twice the percentage in 2003 (14.6%). Comparison of Table 6-12 and 6-35 showed that the major difference between the model estimations of the marginal effects based on the 2003 and 2005 data relate to income. This variable is significant in the model tested on the 2005 data, but not in the case of the 2003 data, and indicates that respondents with higher income were less likely than others to see this issue to be risky in 2005. In 2005, respondents with higher income (an increment measured in a unit of $10,000) were 1% less likely to choose use of food additives as "high risk". Being male reduced the likelihood of choosing "high risk" for the use of food additives by 12.8%.

Some 30% of respondents rated fat and cholesterol in food as a "high risk" issue in 2005 (Table 4-6); only 24% of respondents had chosen this as "high risk" in 2003

(Table 4-5). AGE was a significant variable in 2005 but not in 2003; the marginal effects of this are however, small. In 2005, being 1 year older increased the probability of choosing fat and cholesterol to be "high risk" by 0.3%. Gender is also significant in 2005, with males being 7.2% less likely to see this as "high risk".

Table 6-35 Use of Food Additives, Fat and Cholesterol in Food: Estimated Coefficients for Model 5.4 (Oprobit), 2005 data

	Use of Food Additives		Fat and Cholesterol in Food	
	Coeff.	t-ratio	Coeff.	t-ratio
ONE	0.552	3.417	0.713	4.364
MALE	0.404***	7.017	0.204***	3.551
AGE	-0.006***	-2.945	-0.009***	-4.454
CHILD	-0.046	-1.928	-0.004	-0.174
UNIVER	-0.032	-0.486	0.017	0.261
EMPLOY	-0.063	-1.035	0.056	0.921
INCOME	0.033***	2.954	-0.006	-0.558
BC	-0.033	-0.249	0.119	0.893
PRAIRIE	0.158	1.274	0.218	1.739
ON	0.100	0.867	0.108	0.930
QC	-0.025	-0.209	-0.038	-0.309
TFRIEND	0.139	1.291	0.020	0.180
TNEWS	0.083	1.146	0.053	0.735
TRADIO	-0.138	-1.602	-0.109	-1.254
TINTER	0.014	0.256	0.040	0.714
TDOCTOR	-0.024	-0.330	-0.107	-1.439
TUNIVER	0.003	0.057	0.013	0.215
TGOV	0.069	0.994	0.007	0.101
LL	-1927.025		-1912.264	
Restricted LL	-1967.799		-1934.534	
χ^2	81.54769		44.53992	
Degrees of freedom	17		17	
N	1531		1544	
μ_1	0.935***	30.176	1.000***	31.359
μ_2	2.112****	44.027	2.049***	40.933

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Table 6-36 Use of Food Additives, Fat and Cholesterol in Food, Marginal Effects of Model 5.4 (Orbit), 2005 data

Issues	Variables	High risk	Moderate risk	Slight risk	Almost no risk
Use of Food Additives	MALE	-0.128	-0.027	0.097	0.058
	AGE	0.002	0	-0.002	-0.001
	INCOME	-0.010	-0.002	0.008	0.005
Fat and Cholesterol in Food		High risk	Moderate risk	Slight risk	Almost no risk
	MALE	-0.072	0	0.047	0.025
	AGE	0.003	0.000	-0.002	-0.001

As shown earlier in Tables 4-7 and 4-8, of the various environmental issues associated with modern agriculture, in both 2003 and 2005, many respondents tended to be highly concerned about water pollution by agricultural chemicals (though the percentage of respondents rating this as high risk fell somewhat in 2005 relative to 2003). Specifically, water pollution by agricultural chemicals was rated as "high risk" by 47% of respondents in 2005 while 61% cited this as "high risk" in 2003. The 2005 Oprobit estimation results of risk ratings for three environment issues (water pollution by agriculture, GM/GE on environment and agriculture waste disposal) are presented in Table 6-37 and Table 6-38. For the issue of water pollution from agriculture, MALE, AGE, INCOME, and QC are significant in the estimations based on 2005 data but MALE and INCOME were not significant in 2003. Those who are male were 7.6% less likely to view water pollution from agriculture to be a high risk to the environment; increasing income by $10,000 would decrease the probability of rating GM/GE effect on environment as "high risk" by 0.9%. The marginal effects of AGE and QC have the same signs in the estimations in 2003 (Table6-7) and 2005 (Table 6-37). Older respondents and those who lived in Quebec were more likely to see water pollution as "high risk".

The effect of GM/GE on the environment was seen by 23% of respondents as a high risk issue in 2005 (Table 4-8), while 26% gave this rating in 2003 (Table 4-7). The marginal effects of MALE and INCOME in the model for this issue in 2005 had the same signs as in 2003 (i.e. comparing Tables 6-37 and 6-7), and indicate that males and those with higher incomes tended to rate the influence of GM/GE effects on environment as less risky than did other respondents The estimated marginal effects show that males would be 8.9% less likely to rate the effects of GM/GE use on the environment as "high

risk". Residents in Quebec would be 11.7% more likely to rate the effect of GM/GE on the environment as "high risk". A major difference between the model results based on 2003 and 2005 data is that this coefficient is significant in the Oprobit model in 2005 but not in 2003, suggesting that respondents who lived in Quebec viewed the effects of GM/GE on the environment to be more risky in 2005 than in 2003.

Table 6-37 Estimated Coefficients for Model 5.4 (Oprobit), 2005 data

	Water Pollution		GM/GE (to increase production) on environment		Agricultural waste disposal	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
ONE	0.386	2.297	0.535	3.241	1.058	6.574
MALE	0.190***	3.164	0.292***	5.069	0.249***	4.348
AGE	-0.006**	-2.563	-0.003	-1.224	-0.011***	-5.562
CHILD	-0.017	-0.685	-0.029	-1.218	-0.004	-0.175
UNIVER	-0.127	-1.813	-0.034	-0.510	-0.033	-0.495
EMPLOY	0.006	0.096	-0.057	-0.924	0.000	0.006
INCOME	0.024**	2.091	0.030***	2.634	0.014	1.242
BC	-0.055	-0.407	0.064	0.480	0.029	0.220
PRAIRIE /	0.019	0.149	0.205	1.621	0.012	0.100
ON	-0.169	-1.434	0.159	1.355	-0.211	-1.842
QC	-0.595***	-4.755	-0.360***	-2.943	-0.258**	-2.162
TFRIEND	-0.153	-1.310	-0.187	-1.675	-0.275**	-2.479
TNEWS	0.072	0.961	0.038	0.526	0.017	0.236
TRADIO	-0.041	-0.456	-0.008	-0.095	0.040	0.470
TINTER	-0.028	-0.486	0.064	1.141	0.097	1.740
TDOCTOR	-0.032	-0.418	-0.135	-1.803	-0.037	-0.498
TUNIVER	-0.117	-1.914	0.033	0.565	-0.052	-0.893
TGOV	0.073	1.016	0.095	1.372	0.068	0.987
LL	-1630.745		-1926.30		-2004.919	
Restricted LL	-1673.410		-1982.500		-2041.130	
χ^2	85.320		112.410		72.430	
Degrees of freedom	17.000		17.000		17.000	
N	1555.000		1499.000		1536.000	
μ_1	1.069***	28.530	0.996***	31.830	0.927***	30.892
μ_2	2.164***	29.142	1.947***	44.964	1.819***	43.790

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Agricultural waste disposal was rated by 26% of respondents as a "high risk" issue in 2005 (earlier Table 4-8) and this was the case for 28% of respondents in 2003 (Table 4-7) a similar proportion of respondents giving this a "high risk" rating in each of the two years. Similarities are also found in the Ordered Probit models for this issue based on the 2003 and 2005 data sets, as seen in comparison of Table 6-37 below and earlier Table 6-7. From the marginal effects given in Table 6-8, in 2005 males were 8.2% less likely than females to see agricultural waste disposal as risky, whereas those lived in Quebec were 8.8% more likely than others to see this as a high-risk issue. Those who trusted friends would be 9.6% more likely to see agricultural waste disposal as high risk.

Table 6-38 Marginal Effects of Water pollution, GM/GE (to increase production) on Environment and Agricultural Waste Disposal in 2005 data

Issues	Variables	High risk	Moderate risk	Slight risk	Almost no risk
Water Pollution	MALE	-0.076	0.031	0.037	0.008
	AGE	0.002	-0.001	-0.001	0
	INCOME	-0.01	0.004	0.005	0.001
	QC	0.233	-0.112	-0.101	-0.019
GM/GE (to increase production) on Environment		High risk	Moderate risk	Slight risk	Almost no risk
	MALE	-0.089	-0.023	0.057	0.055
	INCOME	-0.009	-0.002	0.006	0.006
	QC	0.117	0.017	-0.073	-0.061
		High risk	Moderate risk	Slight risk	Almost no risk
Agricultural Waste Disposal	MALE	-0.082	-0.013	0.046	0.049
	AGE	0.004	0.001	-0.002	-0.002
	QC	0.088	0.008	-0.049	-0.047
	TFRIEND	0.096	0.004	-0.054	-0.046

Ordered Probit estimation results based on 2005 data for soil erosion, resistance to herbicides & pesticides and adverse effects of agriculture on biodiversity are presented in Table 6-39 and Table 6-40. In interpreting these it was of interest that soil erosion was rated as high risk by 24% of respondents in 2005 (Table 4-8) and by 27% of respondents in 2003 (Table 4-7). The Ordered Probit model results are similar for the two periods. Tables 6-40 shows that males and those with higher incomes view this issue as a less risky issue but older respondents, those who lived in Quebec, and those who trusted

university scientists were more inclined than others to view soil erosion as risky. Males were 4.8% less likely to rate soil erosion as a high risk and those having an increase in income by $10,000 were 0.8% less likely to rate soil erosion as high risk. Quebec residents were 13.8% more likely to see soil erosion as high risk.

Resistance to herbicides and pesticides was rated to be a high risk for the environment by 50.2% of respondents in 2005 while 46.8% gave this rating in 2003 (earlier Table 4-7). From Table 6-40, males tended to see this issue to be less risky than females in 2005, as was also the case in 2003 (Table 6-25). Those who lived in the Prairie Provinces were 12% less likely to see this issue as "high risk" than others in 2005, but the factor of living in the Prairie region was not a significant factor (i.e. did not affect risk ratings) in 2003. Similarly, older respondents and those who expressed trust in University scientists saw resistance to herbicides and pesticides to be more risky than did other respondents in 2005, but age and having trust in university scientists were found to be insignificant variables in the 2003 data analysis, as seen when Tables 6-39 and Table 6-24 are compared. Male respondent were 12.7% less likely to choose resistance to herbicides and pesticides as "high risk" than were females in 2005 (Table 6-40).

Adverse effects of agriculture on biodiversity was cited by 21.6% of respondents as a high environmental risk issue in 2005 (Table 4-8), while 25.5% of respondents gave this rating in 2003 (Table 4-7). Marginal effects of significant variables in the Oprobit estimation for this issue are listed in Table 6-40. Men were less likely to view adverse effects on biodiversity as risky as women in 2005. Being male would decrease the probability of rating adverse effects on biodiversity by 4.3% in 2005. For those who had a university degree, who lived in Quebec and who trusted university the probability of expressing "high risk" about adverse effects on biodiversity increased by 7.3%., 10.6% and 0.4% respectively. However, comparison of Table 6-40 and Table 6-27 shows that the signs of the marginal effects of MALE are the same for the estimations in each of the two years. Women tended to see adverse effects of agriculture on biodiversity as a high-risk issue in both 2003 and in 2005. However, INCOME, UNIVER and QC were significant in the model tested on 2005 data, but insignificant in 2003, and indicate that in 2005 those with higher incomes, those with a university degree or those who lived in

Quebec were more likely than others to see adverse effects of agriculture on biodiversity as risky in 2005.

Table 6-39 Estimated Coefficients Model 5.4 (Oprobit), 2005 data

	Soil erosion		Resistance to herbicides & pesticides		Adverse effects on biodiversity	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
ONE	1.012	6.230	0.232	1.371	0.569	3.368
MALE	0.152***	2.662	0.319***	5.323	0.140**	2.338
AGE	-0.006***	-3.068	-0.009***	-4.005	0.001	0.466
CHILD	0.039	1.687	0.004	0.148	0.028	1.146
UNIVER	-0.087	-1.297	-0.036	-0.520	-0.228***	-3.303
EMPLOY	-0.058	-0.957	-0.094	-1.483	-0.020	-0.311
INCOME	0.025**	2.203	0.016	1.338	0.041***	3.491
BC	-0.180	-1.371	0.232	1.686	-0.139	-0.995
PRAIRIE	-0.048	-0.384	0.307**	2.368	-0.020	-0.153
ON	-0.137	-1.194	0.147	1.216	-0.137	-1.123
QC	-0.414***	-3.450	-0.238	-1.874	-0.328***	-2.587
TFRIEND	-0.095	-0.871	-0.060	-0.527	-0.013	-0.113
TNEWS	-0.060	-0.832	-0.015	-0.202	-0.012	-0.166
TRADIO	0.122	1.429	0.016	0.181	0.128	1.454
TINTER	0.069	1.241	0.108	1.841	0.062	1.055
TDOCTOR	-0.087	-1.170	0.069	0.899	0.055	0.703
TUNIVER	-0.131**	-2.251	-0.195***	-3.196	-0.132**	-2.157
TGOV	0.077	1.127	-0.019	-0.266	0.144	2.010
LL	-1925.607		-1662.971		-1756.011	
Restricted LL	-1956.730		-1711.690		-1786.050	
χ^2	62.250		97.430		60.070	
Degrees of freedom	17.000		17.000		17.000	
N	1527.000		1554.000		1404.000	
μ_1	1.015***	32.078	1.024***	28.275	0.986***	29.919
μ_2	2.111***	44.901	2.103***	30.373	2.183***	43.085

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Table 6-40 Soil Erosion, Resistance to Herbicides & Pesticides, Adverse Effects on Biodiversity, Marginal Effects of Model 5.4 (Oprobit), 2005 data

Issues	Variables	High risk	Moderate risk	Slight risk	Almost no risk
Soil Erosion	MALE	-0.048	-0.01	0.035	0.022
	AGE	0.002	0	-0.002	-0.001
	INCOME	-0.008	-0.002	0.006	0.004
	QC	0.138	0.012	-0.098	-0.053
	TUNIVER	0.041	0.009	-0.03	-0.019
Resistance to Herbicides & Pesticides		High risk	Moderate risk	Slight risk	Almost no risk
	MALE	-0.127	0.046	0.065	0.016
	AGE	0.004	-0.001	-0.002	0
	PRAIRIE	-0.12	0.036	0.066	0.019
	TUNIVER	0.078	-0.028	-0.04	-0.01
Adverse Effects on Biodiversity		High risk	Moderate risk	Slight risk	Almost no risk
	MALE	-0.043	-0.011	0.035	0.019
	UNIVER	0.073	0.013	-0.057	-0.029
	INCOME	-0.013	-0.003	0.01	0.006
	QC	0.106	0.016	-0.083	-0.04
	TUNIVER	0.004	0.001	-0.003	-0.002

6.6 Summary of Oprobit Results of Risk Ratings Based on the 2005 Data

For all of the OProbit estimations in 2005, the chi-square statistics are statistically significant. The estimated coefficients for MALE were significant in each of the fourteen models. Men were less likely to choose "high risk" than women; they were more likely to select "almost no risk". This finding is consistent with findings in previous studies that females are more likely than males to be concerned about food safety (Flynn et al. 1994; Finke and Kim 2003; Hwang et al. 2005).

The age of respondents was significant in the estimations explaining risk ratings for bacteria contamination, pesticide residuals, use of antibiotics, mad cow disease, use of food additives, fat and cholesterol in food, water pollution by agriculture run-off, agricultural waste disposal, soil erosion and resistance to herbicides and pesticides. Older respondents were more likely to choose these issues as "high risk". This finding is consistent with the estimations from the 2003 data.

The presence of children in a household is only significant in the estimation to explain risk ratings for use of GM/GE to increase food production. The more children in the household, the more likely respondents were to express the use of GM/GE as a "high risk" food issue in 2005.

Education level was found to be associated with risk perceptions. Respondents with a university degree were more likely to see pesticide residuals in food, use of antibiotics and adverse effects of agriculture on biodiversity as "high risk" issues.

Employment status is not a significant factor in influencing risk perceptions in the data collected in 2005. People with higher income were less likely to rate the following issues as "high risk": bacteria contamination in food, pesticide residuals, the use of antibiotics, use of GM/GE in food production, mad cow disease and the use of food additives. A similar influence of higher income is seen to be associated with lower ratings of environmental risk from water pollution from agriculture run-off and GM/GE (to increase production) in the 2005 data. These findings differ from the estimation results for the 2003 data, for which income was not a significant influence on risk ratings. However, the 2005 results for income are consistent with some former findings, such as the observation by Roe et al.(2004) that people with lower income provided higher concern ratings and that US consumers with annual income less than $40,000 were more likely to be concerned about pesticides than those with higher income (Govindasamy et al. 2004).

The location of a respondent's residence influenced risk perceptions in both 2003 and 2005. Those who lived in Quebec were more likely to view the following as "high risk" issues: pesticide residuals, use of antibiotics, use of GM/GE in food production, mad cow disease, water pollution by agriculture run-offs, GM/GE effect on environment and agriculture waste disposal. In contrast, respondents from BC, the Prairie Provinces and Ontario seemed to have more similar types of risk perceptions.

Relative to the trust proxy variable, which queried expressed trust in information sources, TUNIVER (trustworthiness of universities,) NTERNET (trustworthiness of internet), TNEWS (trustworthiness of newspapers and magazines) and TGOV (trustworthiness of government) were the most trustworthy information sources rated in 2005 data. The 2005 estimation results indicate that trusting friends and family,

newspapers and magazines, radio and TV and doctors and nurses as information sources has no significant influence on choice of risk ratings. However, TUNIVER (trusting university research scientists), is significant in the estimation of mad cow disease (BSE), soil erosion, resistance to herbicides and pesticides and adverse effects of agriculture on biodiversity. Those who tended to place more trust in university research scientists, tended to not to choose any of the four mentioned issues as "high risk" and more of them were likely to choose "almost no risk". Those who trusted the Canadian government more were less likely to view pesticide residuals and adverse effects of agriculture on biodiversity as "high risk".

6.7 Statistical Comparison of 2003 and 2005 Ordered Probit Models

To compare the estimated coefficients based on the data for each of the two periods in Ordered Probit estimation, the two data sets are reduced to include only identical explanatory variables. Only the demographic variables, which are identically defined, are kept. For example, the demographic variables such as MALE, AGE, INCOME were kept in both reduced datasets; the variable of BORG (buy organic food) was dropped from the 2003 reduced data set, because there was no such variable in the 2005 survey. The trust proxy variables in the two data sets varied and thus are omitted in this comparison. To further illustrate the difference between the models for the year 2003 and 2005, a dummy variable "year" was created, defined as 0 for 2003 and 1 for 2005. Interactions between the year and the other independent variables are created, specifically, DMALE, DAGE, DEMPLOY, DINCOME, DBC, DPRAIRIE, DON and DQC.

The Ordered Probit model can then be written as:

$Y = f(\beta_1 X + D\beta_2 X)$, $D = 0$ for year 2003; and $D = 1$ for year 2005;

then, $Y = f(\beta_1 X)$, where $D = 0$;

and $Y = f(\beta_1 X + D\beta_2 X)$, where $D = 1$.

The estimation results based on the pooled data set are given in Appendix A. For the issue of bacteria contamination, AGE, CHILD, BC, ON, QC, DCHILD, DPRARIRIE, DQC are significant. The dummy variable YEAR is not significant. CHILD is significant and indicates that respondents with more children were less likely to see bacteria contamination as risky; the interactions between the year and demographic variables

revealed some diversity in risk perceptions: DCHILD is significant, which indicates that s respondents with children in 2005 were more likely to view bacteria contamination to be risky than respondents with children in 2003. The marginal effect DQC shows that Quebec residents were less likely to view bacteria contamination risky in 2005 than in 2003.

For pesticide residuals, the significant variables are MALE, AGE, CHILD, BC, QC, DCHILD and DQC. DCHILD and DCHILD indicates that respondents with children were more likely to view pesticide residuals as risky in 2005 than in 2003, while respondents living in Quebec were less likely to view pesticide residuals to be risky in in 2005 than in 2003.

For the use of hormones, the significant variables are YEAR, MALE, AGE, BC, QC DAGE and DCHILD. The dummy variable YEAR is significant which indicates that the absolute risk concern level changed between 2003 and 2005. Respondents viewed the use of hormones to be more risky in 2005 than in 2003. Older respondents were less likely to see the use of hormones as risky in 2005 than in 2003. Respondents with more children were more likely to rate the use of hormones as risky in 2005 than in 2003.

For the use of antibiotics, the significant variables are MALE, AGE, CHILD, QC, and DCHILD. These results suggest that respondents with more children were more likely to the assess the use of antibiotics to be risky in 2005 than in 2003.

For BSE (Mad Cow Disease), the significant variables are YEAR, AGE, INCOME, BC, ON, QC, DAGE, DON and DQC, which indicates there is a change in the level of concern level about BSE between 2003 and 2005. Respondents tended to view this issue as more risky in 2005 than in 2003. Older respondents and respondents living in Ontario or Quebec were less likely to view BSE as highly risky in 2005 than in 2003.

For food additives, the significant variables are YEAR, MALE, AGE, and EMPLOY, DAGE, DCHILD and DQC. The dummy variable for year is significant and indicates that respondents view food additives to be more risky in 2005 than in 2003.

For the use of GM/GE as a food risk, the significant variables are MALE, EMPLY, INCOME, QC, DCHILD and DQC. Respondents with more children were more likely to view the use of GM/GE to be risky in 2005 than in 2003 while residents in Quebec tended to view the use of GM/GE to be less risky in 2005 than in 2003.

For the issue of fat and cholesterol, the significant variables are YEAR, AGE, CHILD, DCHILD and DPRAIRIE. The estimation results suggest there was a significant change in the level of concern for the issue of fat and cholesterol between 2003 and 2005.

For the environmental issues, considering water pollution, the significant variables are AGE and QC. None of the interactions of dummy variables and independent variables are significant. The lack of significance in the YEAR dummy variable suggests there is no significant change in the concerns about water pollution between the two survey groups ie in 2003 and 2005; however, as noted earlier the K-S test results did suggest a change in the distribution of ratings. For the issue of soil erosion, the significant variables are MALE, CHILD, DCHILD, DINCOME and DQC. Respondents with more children tended to see soil erosion as more risky in 2005 than in 2003. Those with more income were inclined to rate soil erosion as less risky in 2005 than in 2003; but residents living in Quebec tended to view soil erosion as being of more high risk in 2005 than in 2003.

For the issue of the environmental risks from GM/GE use , the significant variables are YEAR, MALE, EMPLOY, DAGE and DEMPLOY. The absolute level of concern changed for the issue of GM/GE between 2003 and 2005. Men and those with more children tended to see more risk in GM/GE on the environment in 2005 than in 2003. However, those who were employed saw less risk in GM/GE on the environment in 2005 than in 2003.

For the environmental issue of resistance to herbicides/ pesticides, the significant variables are YEAR, MALE and QC. Respondents tended to see resistance to herbicides/pesticides as less risky in 2005 than in 2003.For the issue of adverse effects of agriculture on biodiversity, the significant variables are MALE, CHILD and DCHILD. Those with more children tended to see adverse effects of agriculture on biodiversity as more risky in 2005 than in 2003.

From the estimation for of the issue of waste disposal, YEAR, MALE, AGE, DAGE and DINCOME are significant. These results suggest that respondents view waste disposal as more risky in 2005 than in 2003. Older respondents and those with higher incomes tended to see less risk in waste disposal in 2005 than in 2003.

6.8 Summary

This chapter analyzed 2003 data using SUR, Mprobit and Oprobit models. The Oprobit model is concluded to be more suitable.. Therefore, Oprobit model versions are applied to analysis of the 2005 survey data and in making cross-period comparisons involving comparable pooled reduced data sets. Model results are discussed in this chapter. Respondents with different demographic and other behavioural characteristics have different views regarding the risk of food safety and agricultural environment safety issues. One major finding is that male respondents tend to see less risk than female respondents. Another is that Quebec respondents view higher levels of risk for food and agriculture than other Canadians. The next chapter will summarize this study, as well as discuss its limitations, and provide suggestions for further research.

7 DISCUSSIONS AND CONCLUSIONS

7.1 Introduction

This chapter summarizes the findings of this study. Limitations as well as suggestions for further studies are noted in this chapter.

7.2 Summary of Findings

This study focused on attitudes of Canadian consumers towards selected food safety and environmental safety issues associated with agriculture in early 2003 and in late 2005. The two data sets were based on two nation-wide on–line surveys to respondents drawn from representative panels of Canadians. Consumers' risk ratings for the identified issues were hypothesized to be explained by individuals' demographic and attitudinal variables and the influence of these on risk ratings was assessed. Consumers' ratings of risk for the identified issues in the two periods were also compared, since with changes both in food technologies and information on food and environmental safety incidents (such as the finding of three BSE cases in Canada), as well as changes in demographics, consumers' perceptions may have changed in the two year period. Statistical tests were used to examine if there were differences in the postulated models as tested on the 2003 and 2005 datasets.

Eight food safety issues and six environment safety issues were queried in the two surveys. The eight food safety issues were: bacteria contamination, pesticide residuals, use of hormones in food production, use of antibiotics in food production, BSE (mad cow disease), food additives, use of genetic modification/engineering in food production, and fat and cholesterol in food. Risk ratings were given by respondents to each issue. Pesticide residuals (41% cited this as "high risk") was viewed as a high risk issue in 2003, following by bacteria contamination (40.8% in 2003), use of antibiotics (35.6%, in 2003), BSE (mad cow disease) (31.7% in 2003), use of hormones (31.6% in 2003), fat and cholesterol (24.9%, in 2003), use of GM/GE (20.7%, in 2003) and food additives (14.6% in 2003)). The order of these concerns changed somewhat based on the 2005 survey data. The order from high to low was use of hormones (33.4% in 2005), use of

antibiotics (31.3%, in 2005), fat and cholesterol (30.5% in 2005), pesticide residuals (29.2% in 2005), use of GM/GE in crop production (28.6% in 2005), food additives (25.1% in 2005), BSE (mad cow disease 24.1% in 2005) and bacteria contamination (18.4% in 2005). K-S tests were used to test if there were changes in the distributions of risk ratings between 2003 and 2005. These results show that respondents' perceptions for use of antibiotics, and fat and cholesterol did not change appreciably between 2003 and 2005. However, for the issues of bacteria contamination, pesticide residuals, use of hormones, BSE (mad cow disease), food additives, and the use of GM/GE in food production, the distribution of risk ratings was significantly different in these two periods.

The six environment issues are: water pollution (61.3% of respondents cited this as "high risk" in 2003; 47.6% in 2005), resistance to herbicide and pesticides (50.2% in 2003; 46.8%, 2005), agricultural waste disposal (40.8% in 2003; 26.5% in 2005), soil erosion (27.1% in 2003; 24.1% in 2005), GM/GE effect on environment (27.1% in 2003; 23.3% in 2005) and adverse effects of agriculture on biodiversity (25.5% in 2003; 21.6% in 2005). The order of environmental issues ranked by percentages of "high risk" responses remain almost the same in each year except for the issue of adverse effects of agriculture on biodiversity. This is ranked as the third risk in 2003, but as the sixth risk in 2005. The K-S tests show that the distribution of rankings given by respondents did not change significantly for the issue of GM/GE on the environment between 2003 and 2005. Perceptions appear to have changed significantly between 2003 and 2005 for the issues of water pollution, soil erosion, resistance to herbicides & pesticides, adverse effects on biodiversity and agricultural waste disposal.

Three different models (SUR, Mprobit and Oprobit) were initially used in estimations to explain risk ratings in terms of socio-economic and demographic features of respondents based on the 2003 data. The ordered probit model was concluded to be more suitable than the other two types of models. This model was applied in subsequent analysis of 2005 data and also in reduced data estimations to assess how risk assessments appear to have changed between the two periods.

From these estimations, we found gender, age, income and employment to have appreciable impacts on risk attitudes and conclude that trust in food regulators and the marketing system are also significant influences on risk perceptions for various food and

environmental safety issues. Males generally tended to express less concern for all of the food and environmental safety issues in both years. This finding is consistent with some former studies, such as the findings by Finke and Kim (2003) and Dosman et al., (2001). In the earlier study by Dosman et al.(2001), females were more concerned about health risks from GM foods than males; women were more inclined to consider food additives, food bacteria, and pesticides on food as health risks than men (Dosman et al., 2001). One of the possible reasons for women being more concerned with food safety is that women tend to be responsible for much food purchasing and preparation in households. Our results show that in 2003 older respondents tended to perceive bacteria contamination, use of hormones in food, BSE (mad cow disease), food additives, fat and cholesterol in food and agricultural waste disposal as more risky than younger respondents. In 2005 older respondents tended to consider there to be more risk in the following issues: bacteria contamination, pesticide residuals, use of antibiotics, mad cow disease, use of food additives, fat and cholesterol in food, water pollution by agriculture run-off, agricultural waste disposal, soil erosion and resistance to herbicides and pesticides.

The more children there were in respondents' households, the less likely was there to be a concern about the food risk issues of: bacteria contamination, use of antibiotics, and fat and cholesterol in 2003. However, findings in 2005 indicate that the more children in the household, the more likely respondents were to express the use of GM/GE as a "high risk" food issue that year..

Respondents with higher education levels were less likely to consider BSE and GM/GE as high food risks in 2003.Those who were full or part-time employed were more likely to view herbicides & pesticide resistance, food additives, and GM/GE to be highly risky in 2003. However, employment status is not found to be significant in the model estimations on 2005 data. Moreover, Quebec residents were more likely to perceive risk for most of the cited food and environment issues in the 2003 and 2005 data sets.

Trustworthiness of various information sources was found to be an explanator of some safety issues in the data collected in 2003. Those who trusted governments more tended to view pesticide residuals, BSE (mad cow disease), food additives, and GM/GE (relative to a food risk and on the environment) as less risky. Seeing trustworthiness of the food industry, farmers' association, family and friends, and research institutes seemed

to reduce risk assessments of certain food and environmental safety issues, while trustworthiness of consumer associations tended to increase the probabilities of choosing food additives as risky as well as GM/GE as a food risk, and GM/GE as an environment risk.

Respondents' risk perceptions for food safety issues showed some changes in late 2005, compared with the earlier survey, although there were generally less changes for the environmental safety issues. However, statistical analysis suggests women, older respondents and residents of Quebec still tended to rate risks relatively higher than did other respondents. Detailed analysis was made in comparison of the data sets for the two years. The data suggests that changes occurred in the time separating the two years of data except for the issue of use of antibiotics, fat and cholesterol and GM/GE on environment. Some subgroups of respondents seem to have changed their attitudes somewhat in October 2005 relative to January 2003. For example, respondents living in Quebec tended to view pesticide residuals to be more risky in 2005 than in 2003.

7.3 Study Limitation and Further Research

This study used direct questions of risk ratings to measure respondents' risk perceptions. Further research could give more information about consumers' attitudes based on behavior. Experiments could be designed to measure consumers' perceptions of food risk based on real data and stated preference data from experiments. Other limitations may arise from the data collection. The study used on-line surveys applied to representative panels maintained by major marketing companies. Respondents were found to be over sampled for higher levels of education and higher income, although the samples were drawn from a large panel. Consumers with lower levels of education and lower income groups may not be fully represented in this research. The sample could be reduced in size to rectify this but this would result in a loss of data. Mail surveys and face to face interviews combined with on-line surveys are other methods that could help to reduce over sampling.

In addition, extensions in econometric techniques, such as multivariate ordered probit models need to be developed. Further research should proceed to improve modeling. Systems of ordered modeling appear to be likely to better capture respondent's opinions given as ordered rankings.

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APPENDIX A: Estimated Coefficients Based on Reduced Data Sets

	Bacteria Contamination		Pesticide Residual		Use of Hormones	
Variable name	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Constant	1.072	4.960	0.947	4.374	1.013	4.629
YEAR	-0.280	-1.047	-0.374	-1.393	-0.603**	-2.207
MALE	0.110	1.397	0.312***	3.926	0.222***	2.794
AGE	-0.008***	-2.695	-0.010***	-3.047	-0.011***	-3.690
CHILD	0.087**	2.395	0.071**	1.966	0.063	1.748
EMPLOY	-0.056	-0.664	-0.001	-0.014	-0.114	-1.358
INCOME	0.011	0.680	0.000	-0.021	0.023	1.516
BC	-0.433**	-2.397	-0.400**	-2.196	-0.402**	-2.170
PRAIRIE	-0.337	-1.952	-0.317	-1.831	-0.024	-0.138
ON	-0.380**	-2.505	-0.243	-1.607	-0.197	-1.273
QC	-0.773***	-4.910	-0.721***	-4.601	-0.410**	-2.576
DMALE	0.123	1.273	0.055	0.564	0.069	0.698
DAGE	0.004	1.161	0.003	0.828	0.008**	2.038
DCHILD	-0.122***	-2.840	-0.099**	-2.280	-0.104**	-2.365
DEMPLOY	0.045	0.421	-0.105	-0.983	0.032	0.300
DINCOME	0.012	0.660	0.033	1.759	-0.004	-0.229
DBC	0.422	1.902	0.422	1.886	0.339	1.478
DPRAIRIE	0.467**	2.212	0.366	1.723	0.165	0.764
DON	0.234	1.239	0.155	0.822	0.184	0.947
DQC	0.667***	3.399	0.463***	2.358	0.209	1.040
LL	-3031.91		-2956.39		-2911.349	
Restricted LL	-3108.70		-3030.38		-2963.259	
χ^2	153.570		147.98		103.8204	
Degree of freedom	19		19		19	
N	2391		2393		2323	
μ_1	0.885***	36.425	0.876***	35.520	0.906***	36.142
μ_2	2.006***	54.726	1.959***	48.952	1.852***	48.316

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Estimated Coefficients Based on Reduced Data Sets (Cont'd)

	Use of Antibiotics		BSE (Mad Cow Disease)		Food Additives	
Variable name	Coefficient	t-ratio	coefficient	t-ratio	coefficient	t-ratio
Constant	0.673	3.047	1.527	6.700	1.432	6.827
YEAR	-0.111	-0.403	-1.152***	-4.112	-0.572**	-2.173
MALE	0.352**	4.390	0.155	1.924	0.311***	4.082
AGE	-0.007**	-2.238	-0.011***	-3.532	-0.013***	-4.337
CHILD	0.086**	2.328	0.014	0.377	0.025	0.720
EMPLOY	-0.056	-0.643	-0.115	-1.344	-0.230***	-2.837
INCOME	0.030	1.898	0.042***	2.681	0.020	1.348
BC	-0.320	-1.737	-0.412**	-2.151	-0.065	-0.373
PRAIRIE	-0.084	-0.486	-0.266	-1.439	-0.111	-0.661
ON	-0.300	-1.950	-0.500***	-3.059	-0.156	-1.059
QC	-0.622***	-3.912	-0.995***	-5.921	0.025	0.166
DMALE	-0.099	-0.996	0.098	0.991	-0.077	-0.817
DAGE	0.001	0.282	0.009**	2.249	0.008**	2.127
DCHILD	-0.120***	-2.701	-0.060	-1.354	-0.092**	-2.176
DEMPLOY	0.060	0.548	0.049	0.449	0.179	1.722
DINCOME	-0.014	-0.725	-0.021	-1.091	0.027	1.472
DBC	0.259	1.129	0.430	1.844	0.112	0.514
DPRAIRIE	0.161	0.746	0.360	1.608	0.332	1.593
DON	0.225	1.154	0.570***	2.845	-0.039	-0.209
DQC	0.336	1.665	0.719***	3.469	-0.451**	-2.347
LL	-2917.57		-3137.542		-3182.83	
Restricted LL	-2973.61		-3233.412		-3263.47	
χ^2	112.08		191.74		161.28	
Degree of freedom	19		19		19	
N	2288		2349		2396	
μ_1	0.816***	33.817	0.613***	28.988	0.840***	36.283
μ_2	1.728***	47.499	1.327***	45.002	1.776***	57.314

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Estimated Coefficients Based on Reduced Data Sets (Cont'd)

	Use of GM/GE		Fat and Cholesterol	
Variable name	coefficient	t-ratio	coefficient	t-ratio
Constant	1.079	4.895	1.495	7.081
YEAR	-0.524	-1.927	-0.750***	-2.824
MALE	0.448***	5.654	0.092	1.213
AGE	-0.004	-1.371	-0.016***	-5.301
CHILD	0.053	1.466	0.101***	2.901
EMPLOY	-0.240***	-2.821	-0.039	-0.482
INCOME	0.044***	2.809	-0.016	-1.109
BC	-0.361	-1.955	-0.146	-0.823
PRAIRIE	-0.006	-0.031	-0.235	-1.385
ON	-0.200	-1.286	-0.111	-0.747
QC	-0.576***	-3.612	-0.063	-0.416
DMALE	-0.077	-0.794	0.117	1.231
DAGE	-0.002	-0.458	0.007	1.779
DCHILD	-0.095**	-2.191	-0.105**	-2.490
DEMPLOY	0.160	1.495	0.068	0.654
DINCOME	-0.015	-0.809	0.013	0.692
DBC	0.327	1.446	0.260	1.174
DPRAIRIE	0.156	0.717	0.453**	2.148
DON	0.293	1.516	0.215	1.141
DQC	0.544***	2.733	0.029	0.149
LL	-3042.09		-3010.05	
Restricted LL	-3144.26		-3064.98	
χ^2	204.34		109.85	
Degree of freedom	19		19	
N	2346		2417	
μ_1	0.856***	35.748	1.038***	40.593
μ_2	1.888***	54.709	2.039***	53.419

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Estimated Coefficients Based on Reduced Data Sets (Cont'd)

	Water pollution		Soil Erosion		GM/GE	
Variable name	coefficient	t-ratio	coefficient	t-ratio	coefficient	t-ratio
Constant	0.102	0.440	0.479	2.235	0.473	2.173
YEAR	0.229	0.803	0.090	0.332	0.562**	2.085
MALE	0.119	1.392	0.226***	2.943	0.409***	5.193
AGE	-0.009***	-2.594	-0.004	-1.272	-0.002	-0.615
CHILD	0.039	1.021	0.076**	2.162	0.057	1.587
EMPLOY	0.134	1.465	-0.048	-0.583	-0.207**	-2.443
INCOME	-0.019	-1.154	-0.013	-0.869	0.029	1.858
BC	0.088	0.454	0.289	1.609	-0.006	-0.032
PRAIRIE	0.135	0.727	0.098	0.568	0.082	0.472
ON	0.099	0.608	0.220	1.453	0.053	0.350
QC	-0.440**	-2.562	0.156	1.001	-0.298	-1.900
DMALE	0.061	0.591	0.074	0.774	-0.162	-1.665
DAGE	0.003	0.714	0.002	0.459	-0.009**	-2.458
DCHILD	-0.056	-1.230	-0.106**	-2.478	-0.061	-1.418
DEMPLOY	-0.144	-1.262	0.011	0.103	0.212**	1.983
DINCOME	0.039	1.943	0.042**	2.263	-0.015	-0.821
DBC	-0.147	-0.623	-0.244	-1.092	0.012	0.055
DPRAIRIE	-0.116	-0.519	0.107	0.498	-0.076	-0.358
DON	-0.268	-1.333	-0.069	-0.363	-0.266	-1.398
DQC	-0.152	-0.718	-0.527***	-2.666	0.038	0.194
LL	-2422.03		-2976.316		-3095.33	
Restricted LL	-2504.31		-3049.821		-3150.99	
χ^2	164.59		147.01		111.32	
Degree of freedom	19		19		19	
N	2426		2349		2359	
μ_1	1.052***	33.921	1.004***	39.595	0.893***	37.393
μ_2	2.057***	34.376	2.019***	54.780	1.771***	53.442

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Estimated Coefficients Based on Reduced Data Sets (Cont'd)

	Resistance to Herbicides/pesticides		Adverse Effect of Ag, on Biodiversity		Waste Disposal	
Variable name	coefficient	t-ratio	coefficient	t-ratio	coefficient	t-ratio
Constant	0.235	1.039	0.534	2.394	1.200	5.554
YEAR	0.742***	2.678	-0.240	-0.860	-0.656**	-2.410
MALE	0.218***	2.674	0.349***	4.349	0.298***	3.813
AGE	-0.006	-1.759	-0.004	-1.111	-0.019***	-6.258
CHILD	0.071	1.921	0.098***	2.684	0.028	0.776
EMPLOY	-0.004	-0.045	-0.059	-0.681	-0.096	-1.151
INCOME	-0.014	-0.916	0.000	-0.021	-0.027	-1.788
BC	0.034	0.180	0.021	0.111	0.002	0.012
PRAIRIE	0.093	0.514	0.032	0.177	0.101	0.577
ON	0.069	0.431	0.007	0.043	0.057	0.373
QC	-0.436***	-2.622	-0.076	-0.475	0.007	0.041
DMALE	-0.072	-0.725	-0.034	-0.336	-0.179	-1.824
DAGE	-0.001	-0.202	-0.006	-1.656	0.020***	5.356
DCHILD	-0.029	-0.666	-0.090**	-2.056	-0.002	-0.045
DEMPLOY	-0.037	-0.336	-0.079	-0.719	0.087	0.807
DINCOME	0.035	1.812	0.014	0.708	0.056***	2.978
DBC	-0.222	-0.967	0.199	0.865	-0.137	-0.599
DPRAIRIE	-0.144	-0.655	0.270	1.224	-0.119	-0.544
DON	-0.206	-1.050	0.147	0.748	-0.180	-0.917
DQC	0.021	0.101	-0.170	-0.835	-0.333	-1.650
LL	-2811.39		-2632.10		-2837.20	
Restricted LL	-2968.53		-2734.38		-2915.67	
χ^2	313.68		204.58		156.93	
Degree of freedom	19		19		19	
N	2383		2339		2273	
μ_1	1.009***	37.833	1.045***	36.779	0.946***	36.789
μ_2	2.097***	49.381	2.104***	42.734	1.983***	50.970

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Estimated Marginal Effects for Bacteria Contamination				
Variable	High risk	Moderate risk	Slight risk	Almost no risk
AGE	0.003	0.001	-0.002	-0.001
CHILD	-0.028	-0.005	0.020	0.013
BC	0.154	0.003	-0.104	-0.053
ON	0.127	0.017	-0.089	-0.056
QC	0.274	-0.001	-0.180	-0.094
DCHILD	0.040	0.007	-0.028	-0.019
DPRAIRI	-0.134	-0.050	0.093	0.091
DQC	-0.184	-0.077	0.123	0.138
Estimated Marginal Effects for Pesticide Residual				
Variable	High risk	Moderate risk	Slight risk	Almost no risk
MALE	-0.113	0.001	0.074	0.039
AGE	0.004	0.000	-0.002	-0.001
CHILD	-0.026	0.001	0.017	0.009
BC	0.153	-0.021	-0.093	-0.038
QC	0.274	-0.041	-0.164	-0.069
DCHILD	0.036	-0.001	-0.024	-0.012
DQC	-0.156	-0.019	0.104	0.071
Estimated Marginal Effects for Use of Hormones				
Variable	High risk	Moderate risk	Slight risk	Almost no risk
YEAR	0.2103	0.0081	-0.1213	-0.0971
MALE	-0.081	0.0026	0.0467	0.0317
AGE	0.0042	-0.0002	-0.0024	-0.0016
BC	0.1545	-0.0252	-0.084	-0.0453
QC	0.1548	-0.0186	-0.086	-0.0503
DAGE	-0.0028	0.0001	0.0016	0.0011
DCHILD	0.0382	-0.0015	-0.022	-0.0146

Estimated Marginal Effects for Use of Antibiotics				
Variable	High risk	Moderate risk	Slight risk	Almost no risk
MALE	-0.129	0.001	0.070	0.059
AGE	0.003	0.000	-0.001	-0.001
CHILD	-0.032	0.001	0.017	0.014
QC	0.237	-0.029	-0.124	-0.084
DCHILD	0.045	-0.001	-0.024	-0.020
Estimated Marginal Effects for BSE (Mad Cow Disease)				
Variable	High risk	Moderate risk	Slight risk	Almost no risk
YEAR	0.353	0.082	-0.072	-0.362
AGE	0.004	0.001	-0.001	-0.003
INCOME	-0.015	-0.002	0.005	0.012
BC	0.153	0.006	-0.055	-0.104
ON	0.177	0.018	-0.058	-0.137
QC	0.367	-0.004	-0.131	-0.232
DAGE	-0.003	0.000	0.001	0.003
DON	-0.181	-0.044	0.042	0.182
DQC	-0.212	-0.066	0.036	0.242
Estimated Marginal Effects for Food Additives				
Variable	High risk	Moderate risk	Slight risk	Almost no risk
YEAR	0.150	0.075	-0.068	-0.157
MALE	-0.087	-0.037	0.043	0.080
AGE	0.004	0.002	-0.002	-0.003
EMPLOY	0.063	0.029	-0.031	-0.061
DAGE	-0.002	-0.001	0.001	0.002
DCHILD	0.026	0.011	-0.013	-0.024
DQC	0.142	0.034	-0.077	-0.099

Estimated Marginal Effects for Use of GM/GE				
Variable	High risk	Moderate risk	Slight risk	Almost no risk
MALE	-0.136	-0.041	0.083	0.093
EMPLOY	0.072	0.024	-0.044	-0.051
INCOME	-0.014	-0.004	0.009	0.009
QC	0.192	0.027	-0.120	-0.099
DCHILD	0.029	0.008	-0.018	-0.019
DQC	-0.144	-0.071	0.080	0.134
Estimated Marginal Effects for Fat and Cholesterol				
Variable	High risk	Moderate risk	Slight risk	Almost no risk
YEAR	0.235	0.039	-0.154	-0.120
AGE	0.005	0.000	-0.004	-0.002
CHILD	-0.034	-0.002	0.022	0.014
DAGE	-0.002	0.000	0.001	0.001
DCHILD	0.036	0.002	-0.023	-0.014
DPRAIRI	-0.136	-0.035	0.093	0.079

Estimated Marginal Effects for Water pollution				
Variable	High risk	Moderate risk	Slight risk	Almost no risk
AGE	0.004	-0.002	-0.002	0.000
QC	0.171	-0.090	-0.067	-0.015
Estimated Marginal Effects for Soil Erosion				
Variable	High risk	Moderate risk	Slight risk	Almost no risk
MALE	-0.072	-0.013	0.049	0.037
CHILD	-0.024	-0.004	0.017	0.012
DCHILD	0.034	0.006	-0.023	-0.017
DINCOME	-0.014	-0.002	0.009	0.007
DQC	0.185	-0.003	-0.117	-0.066
Estimated Marginal Effects for GM/GE				
Variable	High risk	Moderate risk	Slight risk	Almost no risk
YEAR	-0.194	-0.013	0.104	0.103
MALE	-0.134	-0.022	0.072	0.084
EMPLOY	0.067	0.013	-0.036	-0.043
DMALE	0.055	0.007	-0.030	-0.032
DCHILD	0.020	0.003	-0.011	-0.012
DEMPLOY	-0.070	-0.011	0.038	0.043

Estimated Marginal Effects for Resistance to Herbicides/pesticides				
Variable	High risk	Moderate risk	Slight risk	Almost no risk
YEAR	-0.276	0.044	0.167	0.064
MALE	-0.079	0.005	0.052	0.022
QC	0.164	-0.027	-0.100	-0.037
Estimated Marginal Effects for Adverse Effect of Ag, on Biodiversity				
Variable	High risk	Moderate risk	Slight risk	Almost no risk
MALE	-0.134	0.033	0.076	0.025
CHILD	-0.038	0.010	0.021	0.007
DCHILD	0.035	-0.009	-0.020	-0.006
Estimated Marginal Effects for Waste Disposal				
Variable	High risk	Moderate risk	Slight risk	Almost no risk
YEAR	0.217	0.003	64.313	0.000
MALE	-0.103	0.011	-9.725	0.000
AGE	0.007	0.001	6.233	0.000
DAGE	-0.007	0.001	-5.340	0.000
DINCOME	-0.020	0.007	-2.976	0.003

APPENDIX B: 2003 survey questionnaire (Please note that this study used only a portion of the data from this survey).

Introduction at Site

Welcome!

Thanks again for agreeing to take part in this research.

As you go through the survey, please take time to answer each question, as you can only move from one page to the next after answering all questions. **To go forward or backward, please use the next page/pervious page buttons at the bottom of each page, NOT the Forward/Back button on your browser.**

There are two parts to this survey – a purchase simulation and a questionnaire. **We ask that you complete all parts of the purchase simulation in one session.** If at any time after that you wish to stop the questionnaire and complete it at a later time, please click on the Stop button located at the bottom of the questionnaire, and come back to it at your convenience. When you return to the survey site you will be required to enter your PIN and the questionnaire will begin again where you left off.

[Screener]

S1. Which of the following types of bread do you ever purchase? **CHECK ALL THAT APPLY**

Sliced, pre-packaged store brand
Sliced, pre-packaged national brand
Fresh bakery bread
Make my own
Never buy bread
DK/NS

CONTINUE IF SLICED PRE-PACKAGED STORE BRAND AND/OR SLICED PRE-PACKAGED NATIONAL BRAND, ALL OTHERS THANK & TERMINATE

In this survey, we are interested in your choices of pre-packaged sliced loaf bread that you typically buy at the grocery store. By "sliced loaf bread" we mean the bread that is often purchased for breakfast or sandwiches, like the breads shown in the picture below. We will ask you questions about your preferred bread choices, and your opinions about your bread's nutrition contents and health aspects.

[QUESTIONNAIRE]

[Your Typical Bread Purchase]

Q1. We would like to start this survey by learning more about pre-packaged bread that you normally buy in the grocery store. Please tell us about your **typical bread purchase**. Assume that the bread you buy is **fresh** and **well presented** (i.e. no damaged slices, packaging, etc.).

We understand that you might purchase a variety of different types of bread at different times. However, for the purpose of this study, please indicate which characteristic you **most often** select for each feature of loaf bread presented below [i.e., brand, type of flour, loaf consistency, price, thickness of slices and shape] when purchasing bread.

a) **BRAND: I <u>most often</u> purchase... CHECK ONE ONLY**

National brand [sliced, pre-packaged, for example, Dempster's, Wonderbread, Ovenjoy, Olafson, Healthy Way, etc.]

Store brand [sliced, pre-packaged, for example, President's Choice, Western Family, Safeway, IGA, etc.]

b) **PRICE: I <u>most often</u> purchase… CHECK ONE ONLY**

\$0.99 / 600g loaf
\$1.00 to \$1.99 / 600g loaf
\$2.00 to \$2.99 / 600g loaf
\$3.00 to \$3.99 / 600g loaf
\$4.00 or more / 600g loaf

c) **TYPE OF FLOUR: I <u>most often</u> purchase… CHECK ONE ONLY**

White
Partly whole wheat [60%]
Whole wheat [100%]
Multigrain

d) **LOAF CONSISTENCY: I <u>most often</u> purchase… CHECK ONE ONLY**

Dense loaf consistency
Soft loaf consistency

e) **BREAD CRUST: I <u>most often</u> purchase… CHECK ONE ONLY**

Light brown, soft crust
Mid brown, crunchy crust

f) **THICKNESS OF SLICES: I <u>most often</u> purchase… CHECK ONE ONLY**

Regular slices
Thick slices

g) **SHAPE OF SLICES: I <u>most often</u> purchase… CHECK ONE ONLY**

Sandwich loaf, square slices
Rounded-top slices

Q2. a) For the following question, even if you are not sure of the answer, we are interested in your <u>perceptions</u> of the bread you most often buy. Based on what you know or what you think, is the bread you **most often** buy … **[RANDOMIZE ORDER OF PRESENTATION]**

Yes
No
DK/NS

a) Low in fat
b) High in nutrition
c) High in fibre
d) Low in sodium

e) Organic
f) Free of genetically modified/engineered ingredients
g) Free of pesticide residues

ASK Q2b FOR ALL ITEMS DK/NS IN Q2a

b) We understand that you are not sure about whether the bread you buy has these characteristics. However, we would like you to choose a "yes" or "no" based on your perceptions or what you think is most likely. Do you think the bread you most often buy is.....

Probably Yes
Probably No

POSSIBLE ITEMS [INSERT ALL DK/NS FROM Q2a]

a) Low in fat
b) High in nutrition
c) High in fibre
d) Low in sodium
e) Organic
f) Free of genetically modified/engineered ingredients
g) Free of pesticide residues

Q3. How important are the following pre-packaged sliced bread features to you when choosing a loaf of sliced bread to buy in the grocery store?

Very important
Somewhat important
Not very important
Not at all important
DK/NS

a) Brand name
b) Type of bread (e.g., white, whole wheat, multigrain)
c) Price of bread

[PURCHASE SIMULATION 1]

PLEASE TAKE TIME TO CAREFULLY READ THE FOLLOWING INSTRUCTIONS BEFORE PROCEEDING

In this section you will be presented with a series of purchase options for pre-packaged bread. Each option will include a description of different features. For each purchase simulation, you will be asked to indicate your preferred choice.

FOR EACH SCENARIO, please imagine you are planning to purchase pre-packaged bread. You will have a number of different options presented to you on the following screens.

- **Please choose ONLY ONE OPTION on each screen**

- **Assume that the options on EACH SCREEN are the ONLY ones available**
- **DO NOT COMPARE OPTIONS ON DIFFERENT SCREENS**

You may encounter a few options that seem counter-intuitive (e.g. a lower price but a higher number of features). Be assured that **this is not an error** but part of the design of the survey. Simply choose the one bread option that you prefer most based on its characteristics.

Q4. Now suppose you are shopping for sliced bread. The following choices are the ONLY ONES AVAILABLE to you in the grocery store. Again, the bread you buy is FRESH and WELL PRESENTED (i.e. no damaged slices, packaging, etc.) Please examine each choice below, keeping in mind that, in a real-life-situation, you are paying for the product that you choose. Please choose ONE AND ONLY ONE of Option A, Option B or Option C. Please make the choice that closely reflects your real decision.

I would purchase…

Option A
Option B
Option C

Q5. Now suppose you are shopping for sliced bread. The following choices are the ONLY ONES AVAILABLE to you in the grocery store. Again, the bread you buy is FRESH and WELL PRESENTED (i.e. no damaged slices, packaging, etc.) Please examine each choice below, keeping in mind that, in a real-life-situation, you are paying for the product that you choose. Please choose ONE AND ONLY ONE of Option A, Option B or Option C. Please make the choice that closely reflects your real decision.
I would purchase…

Option A
Option B
Option C

EXAMPLE ONLY Case 1

Features	Option A	Option B	Option C
Brand Name	National brand (such as "Old Mill" and "Wonder")	Store brand (such as Safeway and IGA brands)	
Type of Bread	100% whole wheat	60% whole wheat	
Ingredients	Wheat flour, water, yeast, vegetable oil, sugar, salt Contains genetically modified/engineered ingredients.	Wheat flour, water, yeast, vegetable oil, sugar, salt.	I would not buy any bread at all
Price	$1.49	$2.49	

[Consumer Attitudes Towards GM/ GE Ingredients in Food Products]

Q6. Below is a list of possible **food safety** issues. For each, please indicate how much of a health risk you feel *it is to you personally*. [RANDOMIZE ORDER OF PRESENTATION]

High risk
Moderate risk
Slight risk
Almost no risk
DK/NS

Bacteria contamination of food
Pesticide residuals in foods
Use of hormones in food production
Use of antibiotics in food production
BSE (mad cow disease)
Use of food additives
Use of genetic modification / engineering in food production
Fat and cholesterol content

Q7. We would like to get your opinion on possible **environmental safety** issues that might result from modern agriculture. Please indicate how much of a risk you personally believe each issue represents. [RANDOMIZE ORDER OF PRESENTATION]

High risk
Moderate risk
Slight risk
Almost no risk
DK/NS

Water pollution by chemical run-offs from agriculture
Soil erosion through agricultural activity
Genetic modification / engineering
Resistance to herbicides and pesticides
Adverse effects of agriculture on biodiversity
Agricultural waste disposal (e.g., animal manure)

[Knowledge About Genetic Modification / Engineering in Food Products]

We will now ask you several questions about the technology that is referred to as *"genetic modification (GM)" or "genetic engineering (GE)".* We appreciate your

answers as they help us to better understand how familiar the public is with this topic.

Q8. For each of the following statements please indicate whether you believe the statement is *"true"*, *"false"* or that you *"don't know"*. [RANDOMIZE ORDER OF PRESENTATION]

True
False
DK/NS

a) Genetic modification/ engineering can only be applied to plants, but not to animals.
b) By eating a genetically modified/ engineered food, a person's genes will also become modified.
c) Canola, corn, soybean and potato are amongst the genetically modified/ engineered crops currently produced in Canada.
d) Genetically modified/ engineered food items are currently available in Canadian supermarkets.
e) All of the food items in Canadian supermarkets contain genetically modified/ engineered ingredients.
f) Canadian food regulations require the labelling of food items which contain genetically modified/ engineered ingredients.

Q9. How well informed would you say you are about genetically modified/ engineered foods? Would you say…?
Very well informed
Somewhat informed
Not very informed
Not at all informed
DK/NS

[Potential Benefits and Risks of GM Foods]

We would like to get your opinion on issues about applications of genetic modification/ engineering (GM/ GE) in food production. Following is a list of opinion statements. The statements refer to GM/ GE foods derived from animals (such as meat, dairy products, milk, eggs, etc.) as well as derived from crops (grains, oils seeds, etc). In the statements below, we will treat these distinctions as two separate issues.

Q10. Please read each statement carefully and indicate your agreement or disagreement with the statement. **[RANDOMIZE ORDER OF PRESENTATION]**

Strongly agree
Somewhat agree
Somewhat disagree

Strongly disagree
DK/NS

a) The human health benefits of GM/ GE crops outweigh the human health risks.
b) I would sample foods from GM/ GE crops to find out whether I like them.
c) Foods derived from GM/ GE animals are simply not necessary in Canada.
d) Foods derived from GM/ GE crops are less risky for humans than foods derived from GM/ GE animals.
e) I would prefer cheaper foods derived from GM/ GE crops over more expensive GM-free products.
f) Canada should advance the general field of GM/ GE technologies to prevent or cure diseases.
g) The overall benefits for the environment of GM/ GE crops outweigh the overall environmental risks.
h) Increased GM/ GE crops in Canada will lead to a harmful concentration of corporate power.
i) GM/ GE in agriculture is unnatural.
j) GM/ GE applied to livestock will worsen animal welfare.
k) Overall, I am more sceptical of GM/ GE applications in livestock than in crops.
l) Feeding animals with GM/ GE feed is not a concern.
m) All things considered, benefits of GM/ GE in food production outweigh risks.

[Sources of Information About GM Food Products]

Q11. In the past year, how often have you discussed aspects of genetically modified / engineered foods with others? Would you say…. **CHECK ONE RESPONSE ONLY**

Frequently
From time to time
Never
DK/NS

Q12. Suppose you wanted to obtain trustworthy information about genetically modified/ engineered food products. Please indicate how trustworthy you consider each of the following sources to be.
[RANDOMIZE ORDER OF PRESENTATION]

Very trustworthy
Somewhat trustworthy
Not very trustworthy
Not at all trustworthy
DK/NS

a) Canadian Government
b) The food industry
c) Farmers' associations

d) Family / friends
e) Research institutions (e.g., universities)
f) Consumer associations

Q13. We would like to gain an understanding about your actions with respect to GM food products. Please check either "Yes" or "No" for each of the following statements. **[RANDOMIZE ORDER OF PRESENTATION]**

Yes
No
DK/NS

a) The possibility of genetically modified/ engineered content affects my food choices.
b) I purposefully buy food at organic stores to avoid genetically modified/ engineered foods.
c) I donate money to organizations which oppose genetically modified/ engineered foods.
d) I donate money to environmental protection organizations.
e) I have lobbied against genetically modified/ engineered foods.

[Labelling Of GM Foods]

Q14. The following statements concern your opinion regarding the regulation of genetically modified/ engineered foods. Currently, discussions are going on in Canada as to whether or not food that contains genetically modified/ engineered ingredients should be labelled. Food labelling can be either mandatory or voluntary.

> Mandatory labelling requires all producers to clearly and prominently label any product that contains genetically modified/ engineered ingredients. Under a voluntary labelling scheme, producers can choose to label or not to label products that contain genetically modified/ engineered ingredients as long as the information they provided is true, and not misleading or deceptive.
>
> Please indicate your level of agreement or disagreement with each of the following statements. **[RANDOMIZE ORDER OF PRESENTATION]**

Strongly agree
Somewhat agree
Somewhat disagree
Strongly disagree
DK/NS

a) The public is sufficiently involved in the regulation of genetically modified/ engineered foods.
b) Even if food prices were higher, the consumers' "right to know" warrants a mandatory labelling scheme.

c) The decision about introduction of genetically modified/ engineered foods to Canada should be left to experts.
d) There is no need for mandatory labelling of genetically modified/ engineered foods if the final product quality is the same.
e) Voluntary labelling might be used as a marketing tool rather than providing useful consumer information.
f) Stricter regulations for approving genetically modified/ engineered foods are better than a mandatory labelling system for genetically modified/ engineered foods.
g) Overall mandatory labelling is preferable to voluntary labelling.

[Demographic Information]

The following questions are designed to tell us a little about you. This information will only be used to report comparisons among groups of people. Your identity will not be linked to your responses in any way.

Q15. Are you...

Male
Female
Decline to respond

Q16. What is your age?

RECORD NUMBER OF YEARS [**RANGE 18 TO 120**]
Decline to respond

Q17. How many people, including yourself, live in your household?

RECORD NUMBER [**RANGE 1 TO 20**]
Decline to respond

Q18. How many children live in your household?

None
RECORD NUMBER [**RANGE 1 TO 20**]
Decline to respond

ASK Q19 IF ONE OR MORE IN Q18
Q19. And how many children living in your household fall into each of the following age groups?

1 to 4 years
RECORD NUMBER [**RANGE 0 TO 20**]

5 to 11 years

RECORD NUMBER [**RANGE 0 TO 20**]

12 to17 years
RECORD NUMBER [**RANGE 0 TO 20**]

Q20. What is the highest level of education that you have completed? **CHECK ONE ONLY**

Never attended school
Grade school (grades 1 to 9)
Some high school
High school graduate
Post secondary trade or technical school certificate/degree
Some university or college
College diploma/degree
University undergraduate degree
Some post graduate university study
Post graduate university degree (e.g., Masters or Ph.D.)
Decline to respond

Q21. Which of the following best describes your employment status? **PLEASE SELECT ONE ONLY**

Working full- or part-time [**PLEASE SPECIFY OCCUPATION**]
Full- or part-time student
Do unpaid work from home/ homemaker
Retired
Decline to respond

Q22. For classification purposes, what is your total household income before taxes? **CHECK ONE ONLY**

Less than $10,000
$10,000 - $19,999
$20,000 - $29,999
$30,000 - $39,999
$40,000 - $49,999
$50,000 - $59,999
$60,000 - $69,999
$70,000 - $79,999
$80,000 - $89,999
$90,000 - $99,999
More than $100,000
Decline to respond

Q23. How often do you buy organic food products? **CHECK ONE ONLY**

Regularly

Occasionally
Never
DK/NS

Q24. Are you a member of or associated with any consumer group that focuses on issues of food safety?

Yes
No
Decline to respond

Q25. Are you a member of or associated with any environmental group? **CHECK ONE ONLY**

Yes
No
Decline to respond

Participant Debriefing

Dear Survey Participant:

Once again, we would like to take the opportunity to thank you for participating in this survey. Your contribution is much appreciated.

At this point we would also like to explain more about this research. The study is being conducted by the Department of Rural Economy at the University of Alberta in Edmonton, AB. The purpose is to better understand how people view potential risks and benefits of genetically modified/ engineered foods, their likely choices in a purchase context, and the effects of information on choices. The results of this study will be reported in terms of averages only and individual responses will be confidential. The report of these results will be publicly available and may help to improve Canadian food policies.

We point out that at this point in time, genetically modified/ genetically engineered wheat is not approved for use or sale in the Canadian market, and the products suggested in this survey are HYPOTHETICAL products not currently available in the Canadian market.

Again, please be assured that all information from your personal responses will be treated with strict confidentiality and will not be made available to anyone other than the researchers. Participant's responses will not be individually identified. If you have any questions about the interview or the study in general and its results, please contact the investigators at the address and telephone number listed below.

Michele Veeman, Professor
Vic Adamowicz, Professor
Anne Huennemeyer, Assistant Research Professor

Department of Rural Economy
515 General Services Building
University of Alberta
Edmonton, Alberta T6G 2H1
(780)-492 3610

APPENDIX C: 2005 Survey Questionnaire (Please note that this study used only a portion of the data from this survey).

University of Alberta Survey on Public Opinions on Modern Agriculture and Food Research Questionnaire

Section I: Introduction

Introduction

Welcome and thank you for agreeing to take part in this research!

This is a part of a study conducted at the University of Alberta, Edmonton, Alberta. The study is funded by grants from the government funded research agencies Genome Canada, Genome Prairie and the Alberta Agricultural Research Institute. In this survey, we are interested in knowing the directions you would like to see for publicly funded research related to agriculture and food. You will have opportunities to provide your opinions on research areas such as food production, nutrition, the environment, policy, and consumers.

We ask that you complete all parts of the survey. If you have any questions, please feel free to contact us. Our contact information is given both on your consent sheet and at the end of this survey.

Thank you again for participating!

W1 . First, we would like to know your opinions about public service funding. In the following table we list some public services. Compared with their current funding levels, you may wish to either increase or decrease funding to a particular area. Please circle one funding option within each area that best describes your preferences.

Service Area	**Desired Change in Service Area Spending**					
	Reduced Substantially	Reduced Somewhat	Maintain Current Level	Increased Somewhat	Increased Substantially	Unsure
Education services in all levels of public schools	⇓	↓	—	↑	⇑	?
Police and security services	⇓	↓	—	↑	⇑	?
Health care services	⇓	↓	—	↑	⇑	?
Maintaining natural and wildlife reserves	⇓	↓	—	↑	⇑	?
Providing safer food	⇓	↓	—	↑	⇑	?
Highways and roads	⇓	↓	—	↑	⇑	?

Glossary:

Here we provide you with some terms in modern agriculture and food research that we will use in the survey. Please read this information before you continue the survey.

By "food" and "feed", we mean "plant crops used for human food, e.g., wheat or barley (food) and plant crops used for animal feed, e.g., hay, feed barley or feed wheat (feed)." By "non-food" crops we mean plants or parts of plants that are not used for human food (e.g., tobacco plants or tomato leaves are non-food crops).

By "Agricultural Biotechnology" and the application of "Genomic Technologies" we mean
"The scientific manipulation of living organisms, especially at the molecular genetic level, to produce useful products. Gene splicing and use of DNA are major techniques used."
By "genetic modification (GM)" or "genetic engineering (GE)", we mean
"The process that modifies the genetic makeup of an organism, usually by insertion of one or more genes. The genes may come from the same or another organism, even from an unrelated organism." These techniques may be used in plant molecular farming (PMF).

By "Plant Molecular Farming" (PMF) we mean
"The use of plants as a "factory" in agriculture to produce new materials in addition to food, feed and fibre; i.e., plants with new traits grown as crops are harvested for scientifically, medically or industrially useful products." Examples of possible applications of PMF include:

- Interleukin (an enzyme used in treating Crohn's disease) in tobacco: fast growth of tobacco may allow interleukin to be produced in high volumes.
- Edible vaccines in potatoes: these vaccines may substitute for some that require refrigeration and/or sterilization of needles.
- Bioplastics (biodegradable plastic products) in corn: bioplastics may substitute for synthetic plastics currently in use. Industrial enzymes produced in corn are another example.

Although there may be potential benefits from these types of PMF to make medicines, industrial products and new foods, there are also potential risks. Examples of possible risks are:

- Possible contamination of food supply from accidental mixing of PMF plants with food crops.
- Potential mixing of pollen or seeds from PMF plants with possible adverse effects on the environment; e.g., as weeds or by altering the natural ecology.
- Potential adverse effects on wildlife if animals, birds or insects eat PMF plants.

Section II: General Attitudinal Questions

Q1. For each of the issues listed below, please indicate the risk that you believe applies to each issue.

Statements	Your Opinion				
Bacteria contamination of food	OHigh risk	OModerate risk	OSlight risk	OAlmost no risk	ODon't know/Unsure
Pesticide residuals in food	OHigh risk	OModerate risk	OSlight risk	OAlmost no risk	ODon't know/Unsure
Use of hormones in food production	OHigh risk	OModerate risk	OSlight risk	OAlmost no risk	ODon't know/Unsure
Use of antibiotics in food production	OHigh risk	OModerate risk	OSlight risk	OAlmost no risk	ODon't know/Unsure
Genetically modified/engineered crops to increase crop production	OHigh risk	OModerate risk	OSlight risk	OAlmost no risk	ODon't know/Unsure
Drugs (i.e. medicines) made from plant molecular farming though genetic modification/engineering	OHigh risk	OModerate risk	OSlight risk	OAlmost no risk	ODon't know/Unsure
Genetically modified/engineered crops to increase nutritional qualities of food	OHigh risk	OModerate risk	OSlight risk	OAlmost no risk	ODon't know/Unsure
Genetically modified/engineered crops to produce industrial products like plastics, fuel or industrial enzymes	OHigh risk	OModerate risk	OSlight risk	OAlmost no risk	ODon't know/Unsure
BSE (mad cow disease)	OHigh risk	OModerate risk	OSlight risk	OAlmost no risk	ODon't know/Unsure
Use of food additives	OHigh risk	OModerate risk	OSlight risk	OAlmost no risk	ODon't know/Unsure
Fat and cholesterol content	OHigh risk	OModerate risk	OSlight risk	OAlmost no risk	ODon't know/Unsure

Q2. We would also like to have your opinion on possible environmental safety issues that might result from modern agriculture. Please indicate the risk that you believe applies to each issue.

Statements	**Your Opinion**
Water pollution by chemical run-off from agriculture	O High risk O Moderate risk O Slight risk O Almost no risk O Don't know/Unsure
Use of genetically modified/engineered crops to increase crop production	O High risk O Moderate risk O Slight risk O Almost no risk O Don't know/Unsure
Use of genetically modified/engineered crops used for drug (i.e., medicine) production	O High risk O Moderate risk O Slight risk O Almost no risk O Don't know/Unsure
Use of genetically modified/engineered crops to increase nutritional qualities of food	O High risk O Moderate risk O Slight risk O Almost no risk O Don't know/Unsure
Use of genetically modified/engineered crops used for industrial products like plastics, fuel or industrial enzymes	O High risk O Moderate risk O Slight risk O Almost no risk O Don't know/Unsure
Agricultural waste disposal (e.g., animal manure disposal)	O High risk O Moderate risk O Slight risk O Almost no risk O Don't know/Unsure
Soil erosion from agricultural activity	O High risk O Moderate risk O Slight risk O Almost no risk O Don't know/Unsure
Use of herbicides and pesticides	O High risk O Moderate risk O Slight risk O Almost no risk O Don't know/Unsure
Adverse effects of agriculture on biodiversity	O High risk O Moderate risk O Slight risk O Almost no risk O Don't know/Unsure

Section III: Genomic Research Direction Public Choices

We would like to have your opinions on public-funded research projects in plant molecular farming (PMF). The following table describes these areas of research. The first column gives the general categories of projects and the second column provides brief descriptions of the objective of this research area.

Research Categories	**Description**
Health	To develop new and cheaper PMF-based medicinal drugs and vaccines directed to human problems of health and disease
Industry	To develop new and cheaper industrial products like bioplastics and enzymes.
Environment	To assess and limit impacts of PMF on wildlife and ecology as well as on soil, water and other components of the natural environment.
Consumer	To develop nutritionally improved food or food at lower prices.
Social, economic & public policy	To identify and address public, social and ethical concerns and economic implications and to provide guidance on potential regulations (such as patents and labelling).

C1. You are presented below with a series of 8 situations. Each situation contains alternative plans featuring different ways of allocating public research funds to the areas identified above (Health, Industry, Environment, Consumer, and Social & public policy). Each plan includes a description of the percentages of the total available funds that you can vote to be allocated to each research area. You are asked to indicate which plan you believe is the best.

For your information: Currently, the Canadian government funds about one billion dollars a year on agricultural and food research. Since research on PMF is in an early stage, the Canadian government invests roughly 1%, which is about ten million dollars, of its total agricultural and food funding on PMF-related research.

Please take time to carefully read the following instructions before proceeding:

- Suppose the research plans presented in each situation are the ONLY ones available.
- Each plan includes the total amount of research funds relative to the current level in Canada and how these funds are allocated across different research focus areas. Both the total and the focus allocation percentages may vary across plans.
- Each situation is different so please do not compare plans across different situations.

Your decisions are crucial for us to make suggestions to the Canadian government and relevant organizations for their future funding decisions on PMF research. Please make the choice of research plan that most closely reflects your true preference.

Plan A		Plan B		Plan C		Plan D
Maintain the current levels of research funding allocated as:		**Decrease** current research funding by 20% with the remaining funding allocated as:		**Decrease** current research funding by 20% with the remaining funding allocated as:		
Health	30%	Health	10%	Health	30%	
Industry	20%	Industry	20%	Industry	30%	Provide no funding for PMF research
Environment	10%	Environment	30%	Environment	10%	
Consumer	20%	Consumer	20%	Consumer	10%	
Social, economic and public policy	20%	Social, economic and public policy	20%	Social, economic and public policy	20%	
I prefer (choose only one)						
O		O		O		O

Plan A		Plan B		Plan C		Plan D
Maintain the current levels of research funding allocated as:		**Decrease** current research funding by 20% with the remaining funding allocated as:		**Decrease** current research funding by 20% with the remaining funding allocated as:		
Health	30%	Health	10%	Health	30%	
Industry	20%	Industry	30%	Industry	30%	Provide no funding for PMF research
Environment	10%	Environment	10%	Environment	10%	
Consumer	20%	Consumer	20%	Consumer	10%	
Social, economic and public policy	20%	Social, economic and public policy	30%	Social, economic and public policy	20%	
I prefer (choose only one)						
O		O		O		O

Plan A		Plan B		Plan C		Plan D
Maintain the current levels of research funding allocated as:		**Decrease** current research funding by 20% with the remaining funding allocated as:		**Decrease** current research funding by 20% with the remaining funding allocated as:		
Health	30%	Health	20%	Health	20%	
Industry	20%	Industry	30%	Industry	30%	Provide no funding for PMF research
Environment	10%	Environment	20%	Environment	30%	
Consumer	20%	Consumer	10%	Consumer	10%	
Social, economic and public policy	20%	Social, economic and public policy	20%	Social, economic and public policy	10%	
I prefer (choose only one)						
O		O		O		O

Plan A		Plan B		Plan C		Plan D
Maintain the current levels of research funding allocated as:		**Decrease** current research funding by 20% with the remaining funding allocated as:		**Decrease** current research funding by 20% with the remaining funding allocated as:		
Health	30%	Health	30%	Health	20%	
Industry	20%	Industry	20%	Industry	20%	Provide no funding for PMF research
Environment	10%	Environment	20%	Environment	20%	
Consumer	20%	Consumer	10%	Consumer	20%	
Social, economic and public policy	20%	Social, economic and public policy	20%	Social, economic and public policy	20%	
I prefer (choose only one)						
O		O		O		O

Plan A		Plan B		Plan C		Plan D
Maintain the current levels of research funding allocated as:		**Decrease** current research funding by 20% with the remaining funding allocated as:		**Decrease** current research funding by 20% with the remaining funding allocated as:		
Health	30%	Health	30%	Health	10%	
Industry	20%	Industry	20%	Industry	20%	Provide no funding for PMF research
Environment	10%	Environment	20%	Environment	20%	
Consumer	20%	Consumer	20%	Consumer	30%	
Social, economic and public policy	20%	Social, economic and public policy	20%	Social, economic and public policy	20%	
I prefer (choose only one)						
O		O		O		O

Plan A	Plan B	Plan C	Plan D
Maintain the current levels of research funding allocated as:	**Decrease** current research funding by 20% with the remaining funding allocated as:	**Decrease** current research funding by 20% with the remaining funding allocated as:	
Health 30%	Health 30%	Health 20%	
Industry 20%	Industry 30%	Industry 20%	Provide no funding for PMF research
Environment 10%	Environment 10%	Environment 30%	
Consumer 20%	Consumer 10%	Consumer 10%	
Social, economic and public policy 20%	Social, economic and public policy 20%	Social, economic and public policy 20%	
I prefer (choose only one)			
O	O	O	O

Plan A	Plan B	Plan C	Plan D
Maintain the current levels of research funding allocated as:	**Decrease** current research funding by 20% with the remaining funding allocated as:	**Decrease** current research funding by 20% with the remaining funding allocated as:	
Health 30%	Health 30%	Health 30%	
Industry 20%	Industry 30%	Industry 10%	Provide no funding for PMF research
Environment 10%	Environment 10%	Environment 20%	
Consumer 20%	Consumer 20%	Consumer 20%	
Social, economic and public policy 20%	Social, economic and public policy 10%	Social, economic and public policy 20%	
I prefer (choose only one)			
O	O	O	O

Plan A		Plan B		Plan C		Plan D
Maintain the current levels of research funding allocated as:		**Decrease** current research funding by 20% with the remaining funding allocated as:		**Decrease** current research funding by 20% with the remaining funding allocated as:		
Health	30%	Health	20%	Health	30%	
Industry	20%	Industry	30%	Industry	10%	Provide no funding for PMF research
Environment	10%	Environment	20%	Environment	30%	
Consumer	20%	Consumer	20%	Consumer	10%	
Social, economic and public policy	20%	Social, economic and public policy	10%	Social, economic and public policy	20%	
I prefer (choose only one)						
O		O		O		O

C2. After seeing all the previous plans, you may feel that you have not seen a good research funding plan. Here is an opportunity for you to describe the plan you think is best, compared to current funding percentages. Remember that currently the total funding on PMF research is 1% of the Canadian Government's funding on agricultural and food research. If you like the current funding plan, you do not have to fill in the rest of the table. If you are not satisfied with the current plan, please "construct" your most favoured plan for PMF research funding in the second column of the table. You may choose to change the allocations to different PMF areas, choosing any percentages you want, including 0% for one or some research areas, as long as all the percentages add up to 100%. Alternatively you may vote for the government to allocate no funds at all to any PMF research by selecting the last column of the table below.

O I prefer the current plan		O I would like to see the following plan		O I would prefer the government allocate no funds at all to PMF research
1% of the government's annual research funding in PMF related research and allocated as:		I would like to see _____% on PMF related research from the government's annual funding and this should be allocated as:		
Health	30%	Health	_____%	
Industry	20%	Industry	_____%	
Environment	10%	Environment	_____%	
Consumer	20%	Consumer	_____%	
Social, economic and public policy	20%	Social, economic and public policy	_____%	

Section IV: Plant Molecular Farming Questions

We now ask you several questions about the technology of "plant molecular farming". Your answers will help us to better understand how familiar the public is with this topic.

Q3. What is your level of familiarity with plant molecular farming?

- O Very familiar
- O Moderately familiar
- O Slightly familiar
- O Unfamiliar
- O Never heard of this before this survey
- O Don't know/Unsure

Q4. Where would you seek information on plant molecular farming? (check all that apply)

- O Friends and family
- O Newspapers and magazines
- O Radio and TV
- O The internet
- O Other
- O I would not seek any information
- O Don't know/Unsure

Q5. What would be your most trusted sources of information on PMF? (check all that apply)

- O Friends and family
- O Newspapers and magazines
- O Radio and TV
- O The internet
- O Doctors and nurses
- O University research scientists
- O Federal or provincial government

Q6. We would like to have your opinion about potential risks that might result from plant molecular farming. Please check the risk rating that you believe may come with each type of PMF.

PMF to produce better and cheaper **medical drugs**	O High risk O Moderate risk O Slight risk O Almost no risk O Don't know/Unsure
PMF to produce better and cheaper **industrial products**	O High risk O Moderate risk O Slight risk O Almost no risk O Don't know/Unsure
PMF to produce more nutritious and cheaper **foods**	O High risk O Moderate risk O Slight risk O Almost no risk O Don't know/Unsure

Do you believe that any of the following issues are major risks posed by PMF? Please check the level of risk that you believe applies.

Q6.1 Contamination of food supplies.

O High risk O Moderate risk O Slight risk O Almost no risk O Don't know/Unsure

Q6.2 Damage to the environment.

O High risk O Moderate risk O Slight risk O Almost no risk O Don't know/Unsure

Q7. We would like to have your opinion about potential benefits that might result from plant molecular farming. Please check the benefit rating that you believe each type of PMF may bring.

PMF to produce better and cheaper **medical drugs**	OHigh benefit potential OSlight benefit potential ODon't know/Unsure	OModerate benefit potential OAlmost no benefit potential
PMF to produce better and cheaper **industrial products**	OHigh benefit potential OSlight benefit potential ODon't know/Unsure	OModerate benefit potential OAlmost no benefit potential
PMF to produce more nutritious **and cheaper foods**	OHigh benefit potential OSlight benefit potential ODon't know/Unsure	OModerate benefit potential OAlmost no benefit potential

Do you believe in any of the following benefits from PMF? Please check the rating you believe in.

Q7.1 Opportunity for Canada to lead and create job opportunities in a new industry.

OHigh benefit potential OModerate benefit potential OSlight benefit potential
OAlmost no benefit potential ODon't know/Unsure

Q7.2 Production of new drugs that may not be produced by conventional methods or increase in quantities of existing medical drugs at less cost.

OHigh benefit potential OModerate benefit potential OSlight benefit potential
OAlmost no benefit potential ODon't know/Unsure

Q8. What do you believe the general relationships are between the risks and benefits associated with plant molecular farming?

- O Risks probably **significantly** outweigh benefits
- O Risks probably **moderately** outweigh benefits
- O Risks probably **slightly** outweigh benefits
- O Risk probably roughly equivalent to benefits
- O Benefits probably **slightly** outweigh risks
- O Benefits probably **moderately** outweigh risks
- O Benefits probably **significantly** outweigh risks
- O Don't know/Unsure

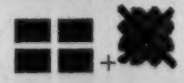
Q9. The following statements are opinions on **the regulation** of plant molecular farming. Please choose your level of agreement or disagreement with each statement by checking the level that you believe.

Statements	**Your Opinion**
Regulators should work with industry in order to manage PMF technology	O Strongly agree O Somewhat agree O Somewhat disagree O Strongly disagree O Don't know/Unsure
Decisions about introduction of plant molecular farming should involve members of the public	O Strongly agree O Somewhat agree O Somewhat disagree O Strongly disagree O Don't know/Unsure
Decisions about introduction of plant molecular farming techniques should be made by scientific experts	O Strongly agree O Somewhat agree O Somewhat disagree O Strongly disagree O Don't know/Unsure
Industry alone should bear the liabilities and costs if there is a problem	O Strongly agree O Somewhat agree O Somewhat disagree O Strongly disagree O Don't know/Unsure
Industry and government should share the liabilities and costs if there is a problem	O Strongly agree O Somewhat agree O Somewhat disagree O Strongly disagree O Don't know/Unsure
The government should strictly regulate plant molecular farming research and monitor environmental and social issues associated with these practices	O Strongly agree O Somewhat agree O Somewhat disagree O Strongly disagree O Don't know/Unsure

Q10. In general, do you believe plant molecular farming should be pursued in Canada?

O Yes
O No
O Don't know/Unsure

Q10a. Assuming that plant molecular farming is pursued, what kind of restrictions do you believe should be put on PMF research before it should be allowed? Please circle the level of restriction under each PMF practice listed below.

Practices	Degree of restriction					
	Lowest restrictions →					Highest restrictions
	Allow to be grown in fields like conventional crops	Allow to be grown in fields **only** with specified isolation in physical distance **or** in time to other crops	Allow to be grown in fields **only** with specified isolation in distance **or** in time to other crops **AND** with no pollen flow (i.e. with plants modified not to flower)	Contained within a greenhouse	Contained within a greenhouse **AND** with plants modified for no pollen flow	**Only** in completely sealed facilities (e.g., underground)
*PMF using **food** crops to produce medicinal **drugs***						
*PMF using **non-food** crops to produce medicinal **drugs***						
*PMF using **food** crops to produce **industrial products***						
*PMF using **non-food** crops to produce **industrial products***						
*PMF using **food** crops to improve **nutritional quality of foods***						

Section V: Demographic Information

The following questions are designed to tell us a little about you. This information will only be used to report comparisons among groups of people. Your identity will not be linked to your responses in any way.

Q11. Are you…

O Male O Female

Q12. What is your age?

_____

Q13. How many people, including yourself, live in your household?

_____

Q14. How many children live in your household?

_____

Q15. And how many children living in your household fall into each of the following age group?

a) 1 to 4 years

_____

b) 5 to 11 years

_____

c) 12 to 17 years

_____

Q16. What is the highest level of education that you have completed? **CHECK ONE ONLY**

O Never attended school
O Grade school (grades 1 to 9)
O Some high school
O High school graduate
O Post secondary trade or technical school certificate/degree
O Some university or college

O College diploma/degree
O University undergraduate degree
O Some post graduate university study
O Post graduate university degree (e.g., Masters or Ph.D.)

Q17. Which of the following best describes your employment status? **PLEASE SELECT ONE ONLY**

O Working full- or part-time
O Full- or part-time student
O Not in the wage labour force
O Retired

Q18. For classification purpose, what is your total household income before taxes? **CHECK ONE ONLY**

O Less than $10,000 O $10,000-$19,999 O $20,000-$29,999
O $30,000-$39,999 O $40,000-$49,999 O $50,000-$59,999
O $60,000-$69,999 O $70,000-$79,999 O $80,000-$89,999
O $90,000-$99,999 O More than $100,000

Q19. What province or territory do you live in?
O Alberta O British Columbia O Manitoba
O New Brunswick O Newfoundland and Labrador O Northwest Territories O Nova Scotia O Nunavut O Ontario
O Prince Edward Island O Quebec O Saskatchewan
O Yukon

Q20. Do you live in a Rural Area?
O Yes
O No

Q21. Do you work in any of the following areas?

O Hospital or health services
O Government or non-government environment agencies
O Food industry (farming, processing, retailing, or food-related industry)
O Research institution
O None of the above

Q22. Are you associated with or donate to any consumer group that focuses on food safety issues?

O Yes
O No

Q23. Are you associated with or donate to any environmental group?

O Yes
O No

Q24. Are you associated with any group that seeks remedies for illness or medical problems?

O Yes
O No